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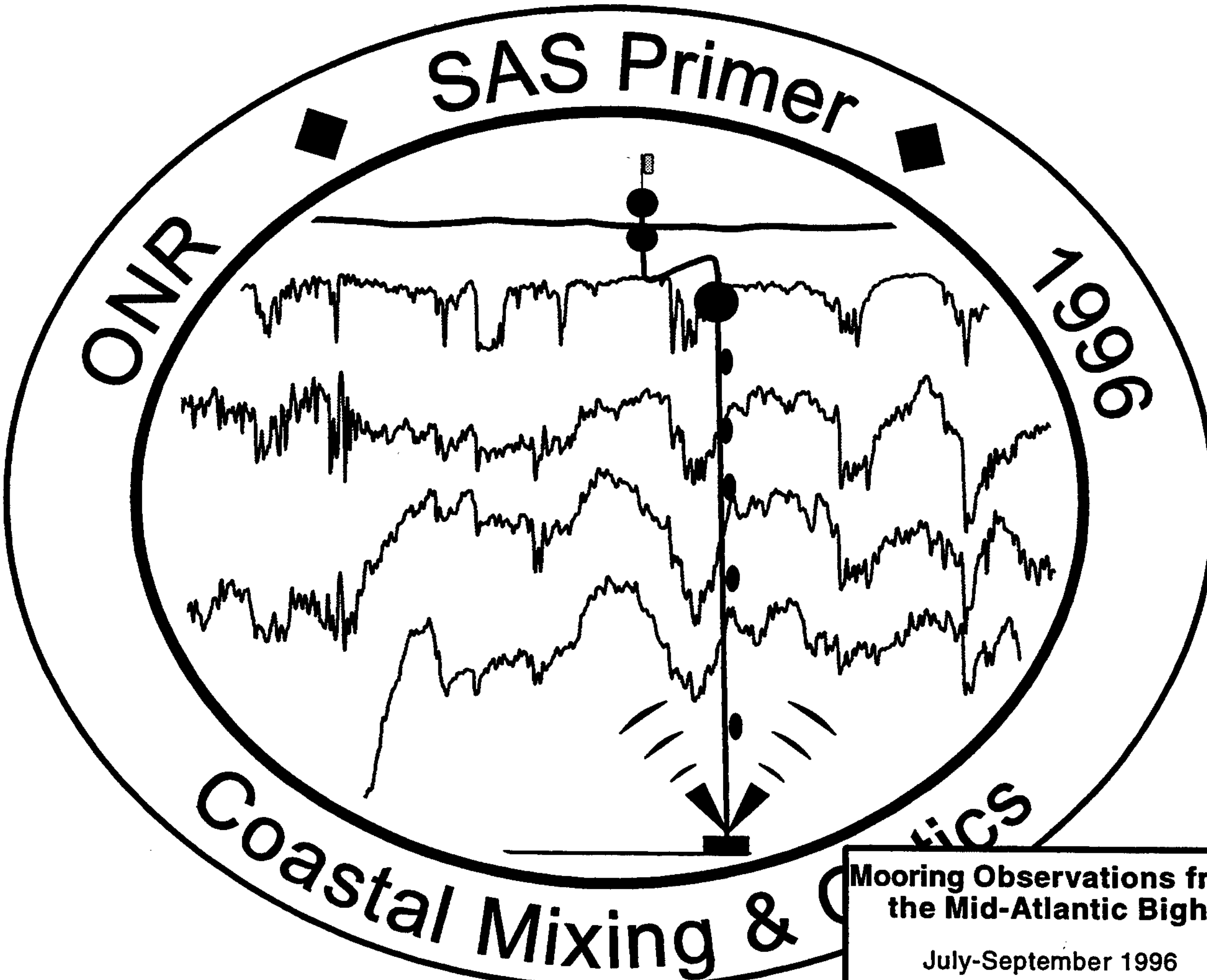

Mooring Observations from the Mid-Atlantic Bight

July-September 1996

Synthetic Aperture Sonar Primer
and
Coastal Mixing & Optics
Programs

by
Timothy Boyd
Murray D. Levine
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Reference 97-2
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Data Report 164

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OREGON STATE UNIVERSITY

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We appreciate the effort of program manager Lou Goodman of the Office of Naval Research in putting together this SAS Primer project. The support through grant N00014-95-1-0534 is gratefully acknowledged.

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INTRODUCTION

This report documents the observations of velocity, temperature and conductivity made in the Mid-Atlantic Bight region of the NW Atlantic Ocean during the Synthetic Aperture Sonar (SAS) Primer experiment. The primary data were obtained from instruments moored in 70 m of water near 40° 30' N, 70° 30' W, from July through September 1996 (Figure 1). Vertical profiles of conductivity, temperature, light transmission and fluorescence were also made during deployment and recovery cruises.

The overall goals of this PRIMER program are to assess the feasibility of the operation of an SAS on the continental shelf. A study of acoustic propagation was conducted during the period the mooring was deployed, from August 20 through August 27, by F. Henyey, T. Ewart, and K. Williams (Applied Physics Laboratory / University of Washington). The evaluation of the synthetic aperture sonar itself was performed by S. Stanic and R. Meredith (Naval Research Laboratory). This project was carried out in close cooperation with the ONR-sponsored Coastal Mixing & Optics ARI. In addition to shared logistical planning, we anticipate joint analysis and sharing of data.

The specific goals of this project are to describe the internal wave field and associated sound speed fluctuations on the shelf--both statistically and by events. The sampling scheme was designed to resolve the many components of the wavefield including: near-inertial waves, internal tide, background continuum and internal solitary waves.

This report is divided into two sections. The first section contains descriptions of the instrumentation deployed on the PRIMER moorings including locations, sampling rates, and calibrations. It also includes a brief description of the CTD sampling and sample profiles from the CTD stations occupied. Copies of the deployment and recovery cruise logs are appended to the first section. The second section contains plots from the mooring deployment. Several views of the time series recorded by the moorings are presented. Time series of vertically separated temperature, salinity, and velocity measurements are shown for the main, subsurface mooring. Temperature observations from sensors at the same depth on horizontally separated mooring are also shown. These data are presented as both low-pass filtered and unfiltered time series. Time is given as day of year 1996 in all of the time series plots; conversion to calendar date is provided in Table 8. The data displayed in these figures are a subset of the data collected during the mooring deployment, all of which are available on CD-ROM from the authors.

MOORINGS and INSTRUMENTATION

Description

The three instrumented moorings were named: OSU Main, OSU Met, and OSU Aux (Figure 2). The detailed schematic diagram of the moorings is shown in Figure 3. The vertical distribution of resulting data is shown in Figure 4. The primary strength member of all the moorings was 1/2" chain.

The OSU Main mooring contained most of the instrumentation (Table 1) with the primary flotation provided by a subsurface 48" sphere. The mooring was designed to be fairly taut; pressure was recorded to track the vertical motion of the mooring. A surface marker float was attached to provide a visual navigational aid. In addition to our instruments, we attached three of

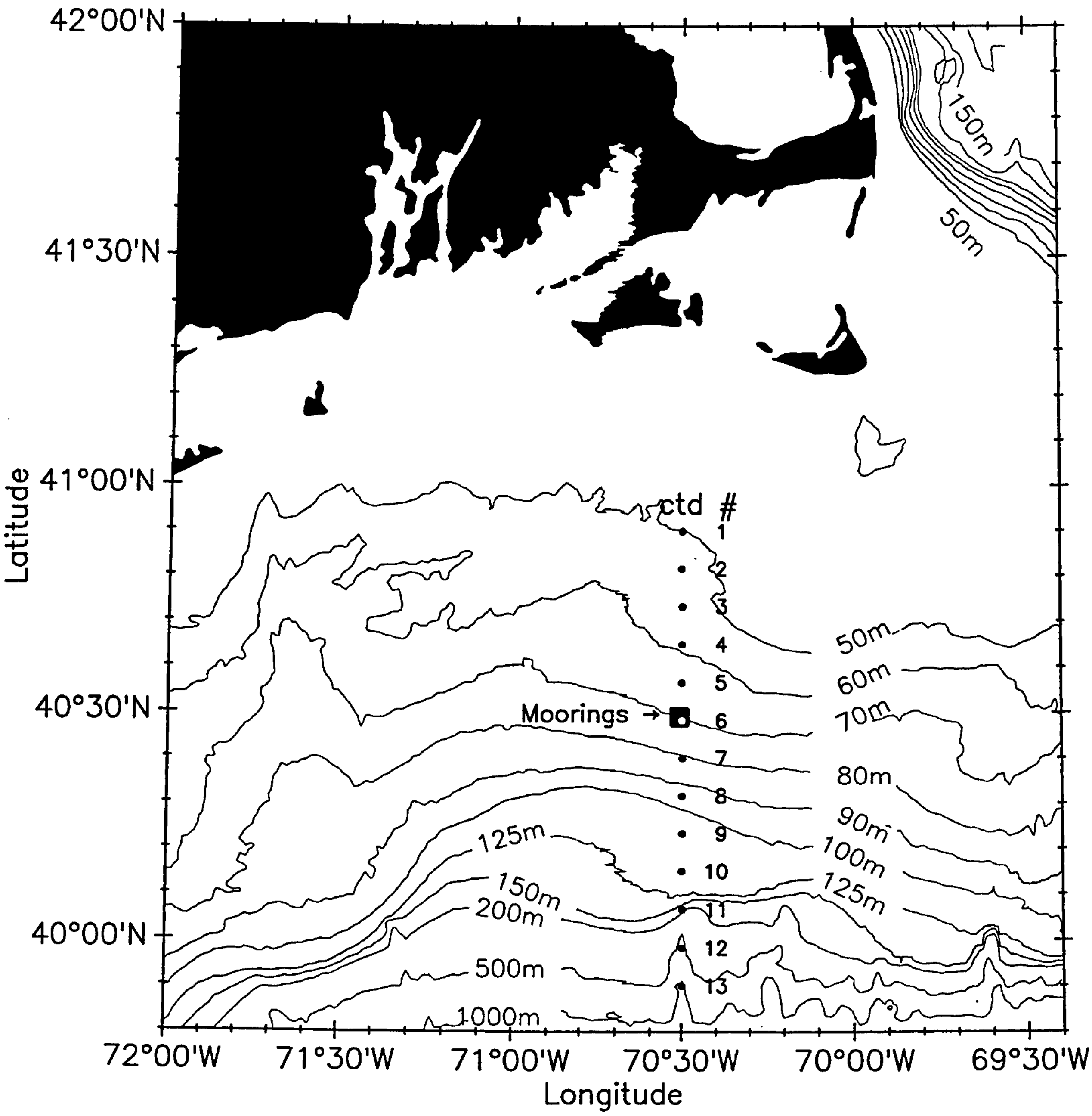


Figure 1. Map of SAS PRIMER and CM&O study areas.

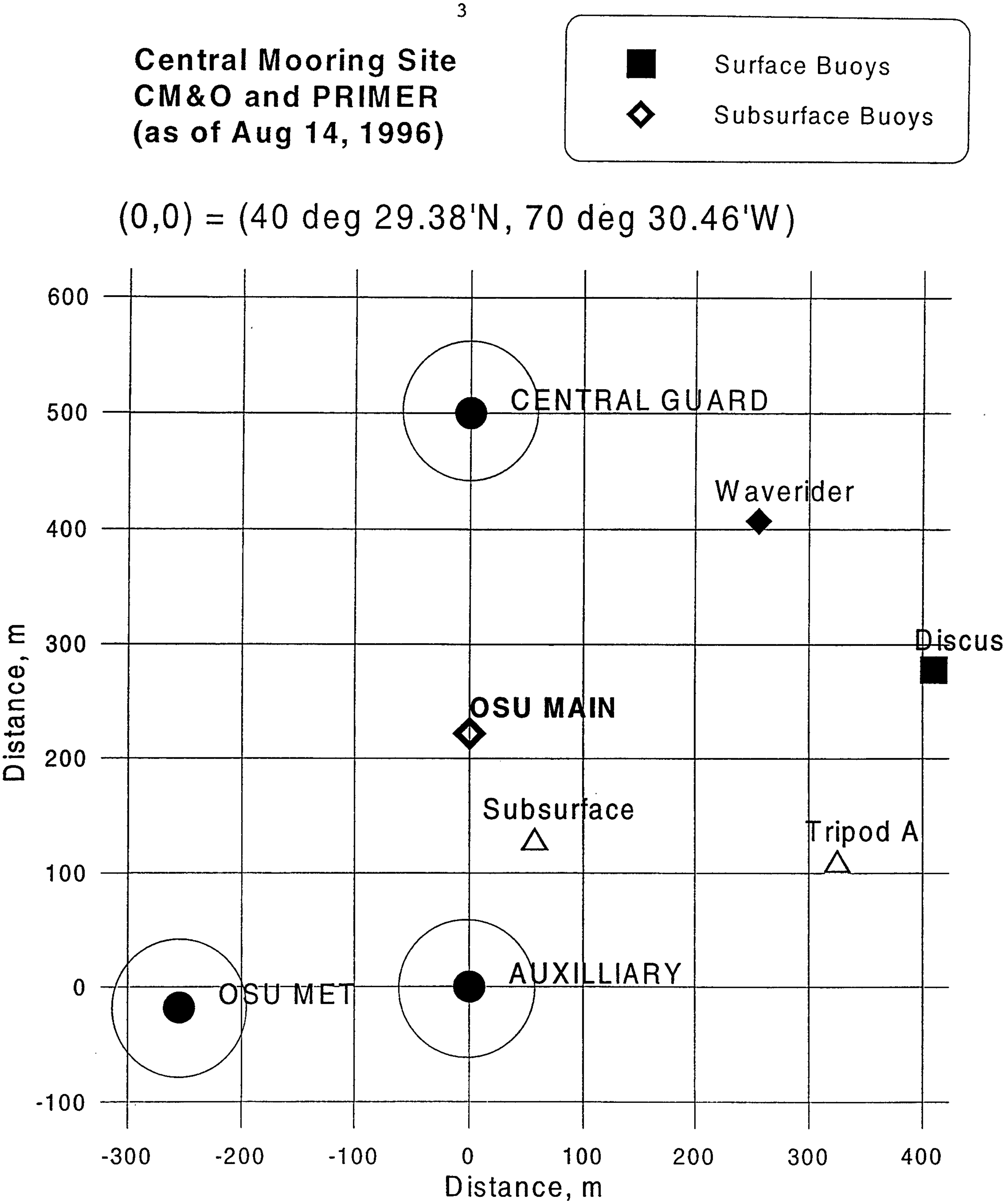
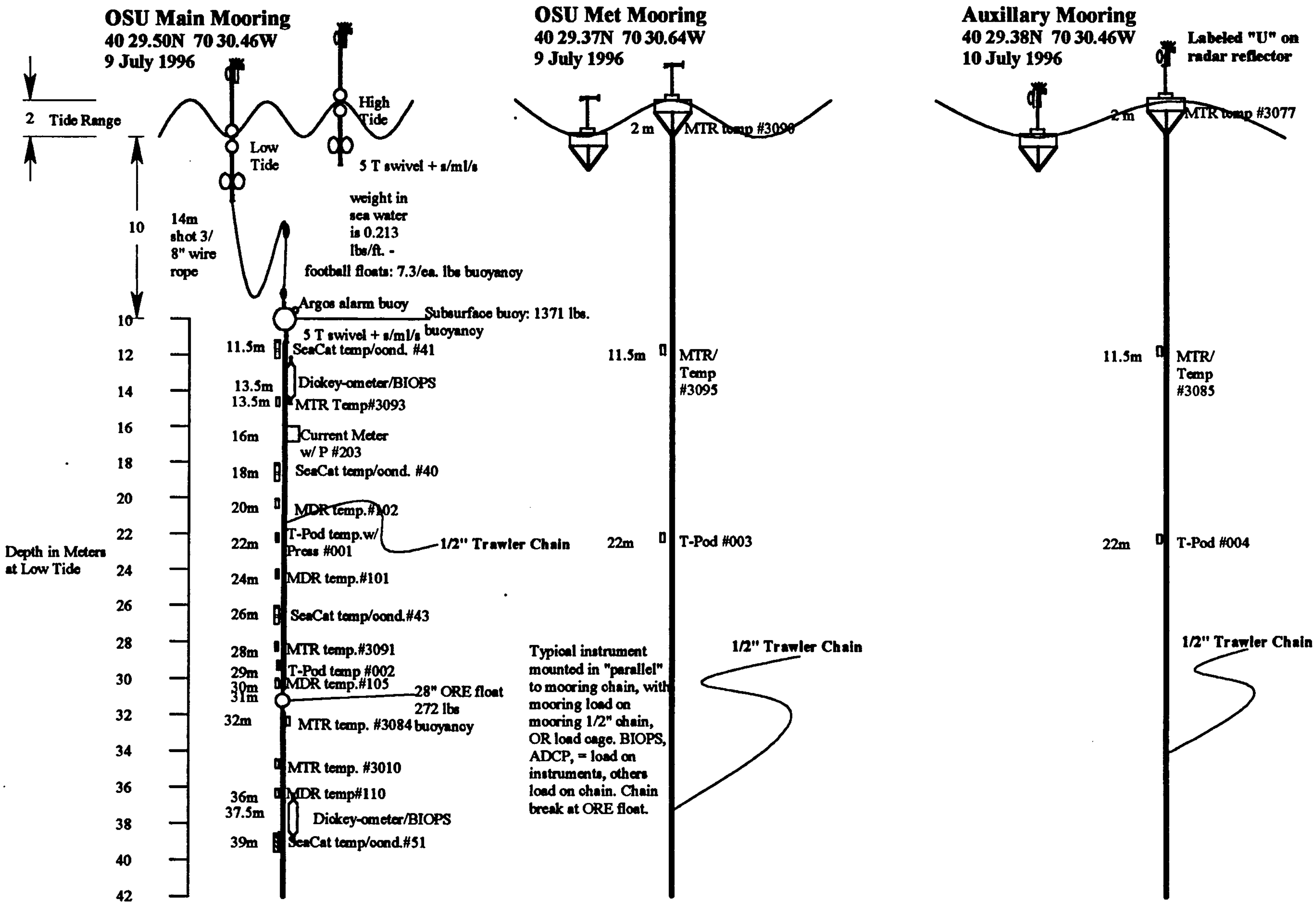


Figure 2. Detailed layout of the mooring site.



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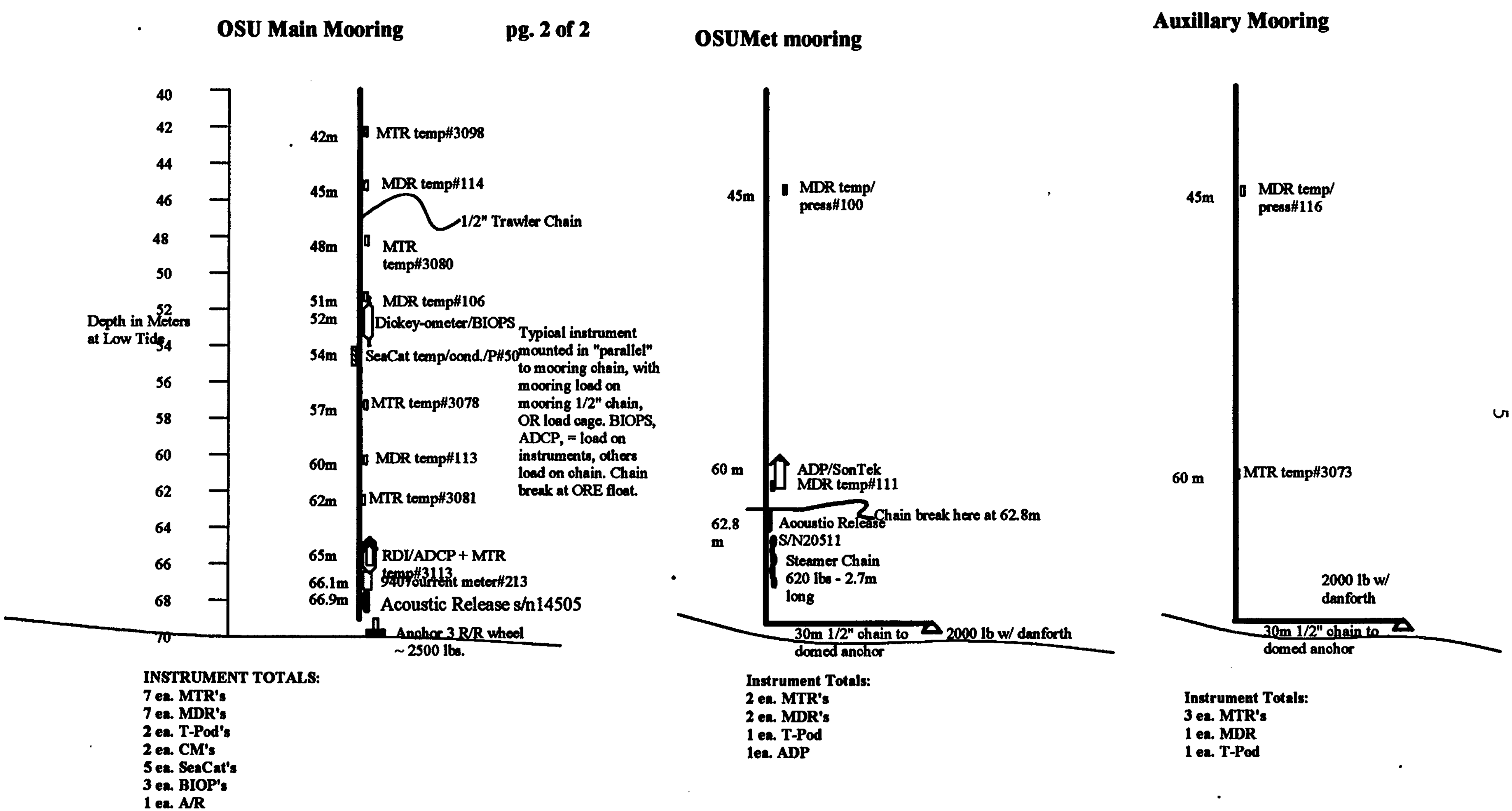


Figure 3. Diagram of OSU Main, Met, and Aux moorings.

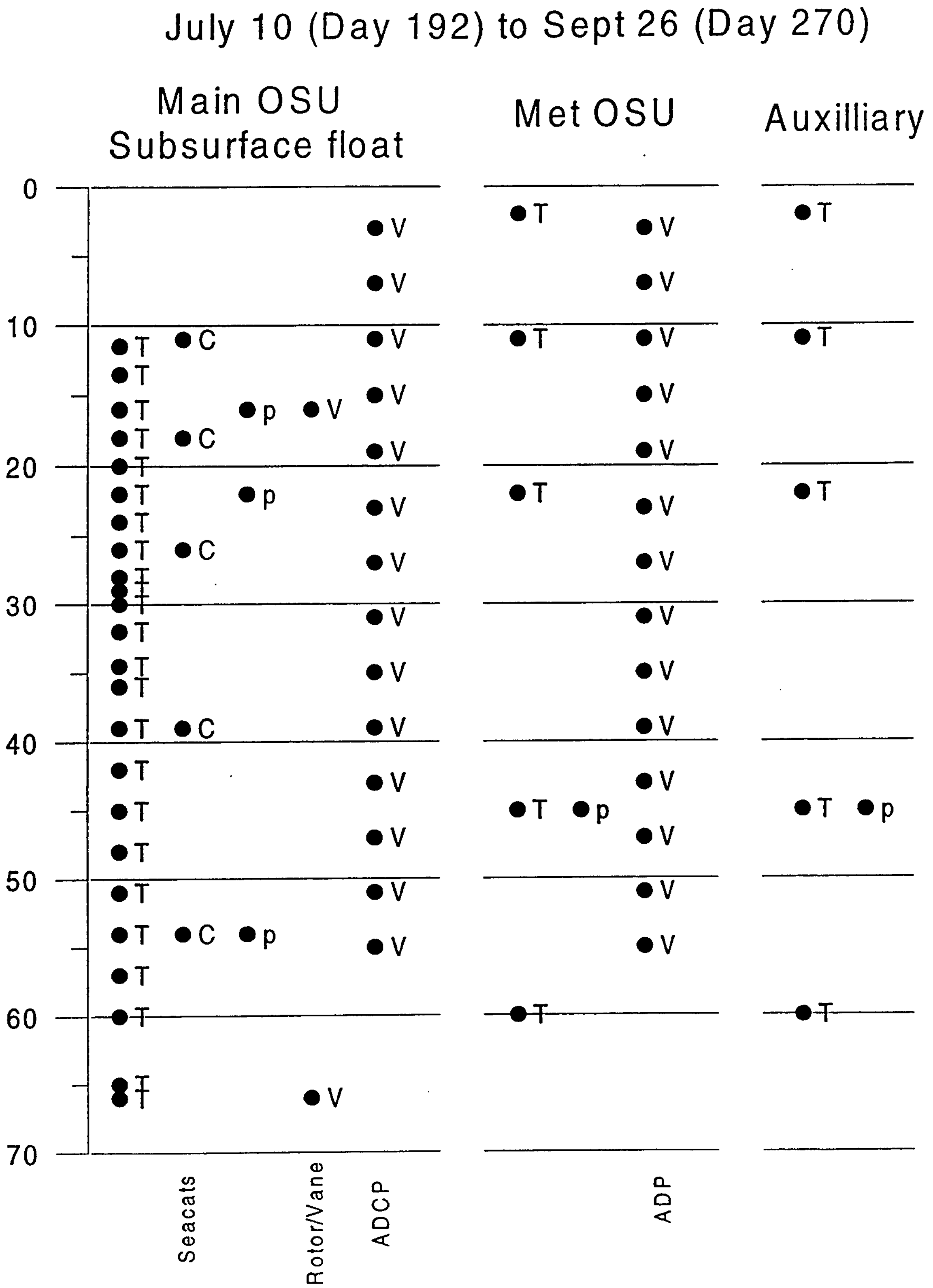


Figure 4. Diagram of parameters sampled on OSU Main, Met, and Aux moorings.

Tommy Dickey's (UCSB) optical instrument packages (BIOPS). The anchor consisted of 3 railroad wheels and weighed about 2500 lbs. An acoustic release was used to avoid the need to retrieve the anchor.

The OSU Met mooring was buoyed by a surface toroid float with a meteorological package. The mooring was designed with a 1.4 scope (length of chain/depth of water) to reduce the probability of dragging the anchor during storms. The 2000 lb. anchor was cast with a domed top to reduce the chances of fouling. A mid-water 620 lb. anchor was attached to keep the mooring line as vertical as possible. A few sensors were attached to the Met mooring chain (Table 2).

The OSU Aux mooring consisted of a surface buoy supplied by Woods Hole Oceanographic Institution and also had a 1.4 scope. The anchor was the same design as used in the OSU Met mooring, however, there was no mid-water anchor. The few sensors that were on the Aux mooring chain are given in Table 3.

Deployment and Recovery

The moorings were deployed and recovered from the *R/V Oceanus* sailing out of WHOI. The complete cruise reports are given in Appendices 1 and 2. The locations of the moorings determined by shipboard GPS (P-code) were:

40° 29.50' N; 70° 30.46' W -- OSU Main
40° 29.37' N; 70° 30.64' W -- OSU Met
40° 29.38' N; 70° 30.46' W -- OSU Aux.

Instrumentation and Setup

For each instrument on the moorings, the depth, manufacturer, sampling rate and calibration information are given in Tables 1, 2, and 3.

The setup information for the Workhorse Acoustic Doppler Current Profiler (ADCP; RD Instruments Inc.) and the Stand-Alone Acoustic Doppler Profiler (ADP; Sontek Inc.) are given in Tables 4 and 5.

Calibration

A pre-cruise temperature calibration was done at OSU in April 1996. Most of the temperature sensors were in the bath at the same time. The bath reference temperature was measured by a pair of Sea-Bird Electronics Inc.(SBE), SBE-3 sensors (#544 and #607) with a stable calibration history. These sensors were also recently calibrated by SBE. A post-cruise calibration was also done at OSU in October 1996.

For each temperature sensor that was in both calibrations, except the Seacats, a comparison was made to see if there was any significant drift or shift. We examined the differences between the calibration equations derived from the pre-cruise and post-cruise calibrations. Factory calibrations were used for the four Alpha-Omega 9311 sensors as there were no pre-cruise calibrations at OSU. Overall the agreement between pre- and post-cruise calibrations was excellent. For most sensors the difference was less than 0.005 °C over the temperature range of interest (8 to 20 °C). The four Alpha-Omega 9311 sensors and two other sensors (#110 and #3085) showed somewhat larger differences. A summary of the differences is given in Tables 1,2, and 3. The pre-cruise calibrations were used for the archived data (except for sensor #101).

The Seacat conductivity and temperature sensors were calibrated by SBE before the cruise

Table 1. OSU Main Mooring Instrumentation (40° 29.50' N; 70° 30.46' W)

Depth, m	Type of measurement[1]	Manufacturer[2]	Model Number	Serial Number	Post - Pre Calibration, 10^{-3} °C [3]	Sampling Rate, minutes
11.5	T,C	SBE	SBE-16	41	0 to 3	2
13.5	T	PMEL	MTR	3093	-1 to 0	2
16	T,V,p	Alpha-Omega	9407	203	N/A	8
18	T,C	SBE	SBE-16	40	0 to 3	2
20	T	Alpha-Omega	9102	102	-2 to 2	2
22	T,p	Alpha-Omega	9311	1	-17 to 0	1
24	T	Alpha-Omega	9102	101	N/A	2
26	T,C	SBE	SBE-16	43	0 to 3	2
28	T	PMEL	MTR	3091	-5 to -3	2
29	T	Alpha-Omega	9311	2	-17 to 0	0.5
30	T	Alpha-Omega	9102	105	-5 to 0	2
32	T	PMEL	MTR	3084	-4 to -3	2
34.5	T	PMEL	MTR	3010	-1 to 0	2
36	T	Alpha-Omega	9102	110	-17 to -11	2
39	T,C	SBE	SBE-16	51	-1 to 2	2
42	T	PMEL	MTR	3098	-2 to -1	2
45	T	Alpha-Omega	9102	114	-7 to -1	2
48	T	PMEL	MTR	3080	-2 to -1	2
51	T	Alpha-Omega	9102	106	-4 to 0	2
54	T,C,p	SBE	SBE-16	50	0 to 2	4 (T,C); 8 (p)
57	T	PMEL	MTR	3078	-3 to -1	2
60	T	Alpha-Omega	9102	113	-5 to -1	2
62	T	PMEL	MTR	3081	No Data	
65	T,V	RDI	ADCP	0067	N/A	2
65	T	PMEL	MTR	3113	-3 to -1	2
66.1	T,V	Alpha-Omega	9407	213	N/A	4

Table 2. OSU Met Mooring Instrumentation (40° 29.37' N; 70° 30.64' W)

Depth, m	Type of measure-ment[1]	Manufacturer[2]	Model Number	Serial Number	Post - Pre Calibration, 10^{-3} °C [3]	Sampling Rate, minutes
2	T	PMEL	MTR	3090	-3 to -2	2
11.5	T	PMEL	MTR	3095	-2 to -1	2
22	T	Alpha-Omega	9311	3	-20 to 0	0.5
45	T,p	Alpha-Omega	9102	100	-4 to 0	4
60	T	Alpha-Omega	9102	111	-2 to 4	2
60	T,V	Sontek	ADP		N/A	2

Table 3. OSU Auxilliary Mooring Instrumentation (40° 29.38' N; 70° 30.46' W)

Depth, m	Type of measure-ment[1]	Manufacturer[2]	Model Number	Serial Number	Post - Pre Calibration, 10^{-3} °C [3]	Sample Rate, minutes
2	T	PMEL	MTR	3077	N/A	2
11.5	T	PMEL	MTR	3085	-10 to -6	2
22.0	T	Alpha-Omega	9311	004	-15 to 0	0.5
45.0	T,p	Alpha-Omega	9102	116	-5 to 0	4
60.0	T	PMEL	MTR	3073	-5 to -3	2

[1] T = temperature, C = conductivity, p = pressure, V = velocity

[2] SBE = SeaBird Electronics, Inc.; PMEL = Pacific Marine Environmental Laboratory, Seattle; Alpha-Omega = Alpha Omega Computer Systems, Corvallis (currently manufactured by Oregon Environmental, Inc., Corvallis); Sontek = Sontek, Inc., San Diego; RDI = RD Instruments, San Diego

[3] Range of temperature differences between post and pre-cruise calibrations over the temperature range 8 to 20°C. N/A = not available

Table 4. ADCP (Acoustic Doppler Current Profiler, RDI Inc.) Sampling Parameters

Parameter	Value	Comment
Acoustic frequency	300 kHz / 4 beams	
Model / serial no.	Workhorse / 0067	Firmware: 8.09 operating; 1.08 boot
Slant angle	20 degrees	
Bin length / number of bins	4 m / 17 bins	
% good minimum	25%	
Number of pings / sample	10	
Sampling interval	120 s	
Blanking distance	1.76 m	
Coordinate system	Earth	
Data filename (binary)	PRIME000.000	26,277,308 bytes
First profile Last profile	0100 7/10/96 GMT 01650 9/27/96 GMT	
Number of profiles	57,356	
Location	OSU Main at 65 m depth	40 deg 29.50' N; 70 deg 30.46'W
Bin depths (center)	59, 55, 51, 47, 43, 39, 35, 31, 27, 23, 19, 15, 11, 7, 3, -1, -5 m	
Salinity used in c_{sound}	35 ppt	not very sensitive to S; 1.2 m/s per ppt
Auxillary sensors	temperature, tilt (2), compass heading	

Table 5. ADP (Acoustic Doppler Profiler, Sontek Inc.) Sampling Parameters

Parameter	Value	Comment
Acoustic frequency	500 kHz / 3 beams	
Model / serial no.	Stand-alone ADP / 4057	
Slant angle	25 degrees	
Cell size / number of cells	4 m / 15 cells	
Averaging interval	45 s	
Number of pings / sample	100	
Sampling interval	120 s	
Blanking distance	1 m	
Coordinate system	Beam	
Data filename (binary)	PRIME001.ADP	15,291,490 bytes
First profile Last profile	0100 7/9/96 GMT 0224 9/28/96 GMT	
Number of profiles	58,363	
Location	Meteorological Buoy at 60 m depth	40 deg 29.37' N; 70 deg 30.64'W
Cell depths (center)	55, 51, 47, 43, 39, 35, 31, 27, 23, 19, 15, 11, 7, 3, -1 m	
Salinity used in c_{sound}	35 ppt	not very sensitive to S; 1.2 m/s per ppt
Auxillary sensors	temperature, tilt (2), compass heading	

(February 1996). These instruments were also included in the OSU temperature calibrations for intercomparison purposes. A comparison of the SBE calibrations with the OSU post-cruise calibrations was done by subtracting the calibration curves. We were quite pleased to find that the differences in the calibration curves were small – less than 0.003 °C absolute over the range of interest (see Table 1). Although there is little difference, we used the pre-cruise SBE calibrations to produce the archived data set.

During the deployment, there was significant algal growth, especially on the upper sensors. Shifts in the conductivity calibration are expected. The Seacat conductivity sensors were not post-calibrated as the condition of the growth around the conductivity cells after shipment to OSU had changed significantly from their *in situ* state. Comparison of the Seacat conductivity time series from the deployment suggest that the calibration of Seacat #40 at 18 m shifted relative to the adjacent Seacats at 11 m and 26 m on day 238.

Pressure calibration was done at OSU for the 5 instruments with pressure sensors using a Paroscientific Digiquartz sensor as the standard.

The compass heading of the current meters was checked after the cruise using the OSU facility. The ADP and ADCP compasses were within 2 degrees of expected values as the instruments underwent a complete rotation. The magnetic declination of 15° 20' W was used to correct the compasses. This value was obtained from the web site of the Geological Survey of Canada (http://www.geolab.nrcan.gc.ca/) for the deployment location: 40° 30' N; 70° 30'W. Calibration of the compasses on the Alpha-Omega model 9407 Vector Averaging Current Meters was performed by the manufacturer prior to deployment.

CTD MEASUREMENTS

CTD casts were made during both deployment and recovery cruises with an internally recording SBE-25 borrowed from Clayton Paulson and prepared by Scott Pegau. The sampling rate was 8 scans/second with a typical lowering rate of 0.6 m/s.

The temperature, conductivity and pressure sensors were calibrated at SBE prior to the deployment cruise. The transmissometer was a Sea Tech, Inc., single wavelength, with a 25-cm-pathlength. Its source is a red-broadband LED with an effective central wavelength of 660 nm. The fluorometer was a WET Labs Wetstar chlorophyll-a fluorometer. It uses a broadband blue LED for a source and detects light emitted at 685 nm.

A north-south section through the mooring site was conducted during each cruise (Figures 1, 5 , and 6). The CTD section consisted of 13 stations during the deployment cruise and 12 stations during the recovery cruise. Stations were separated by 5' latitude. A unique cast number was assigned each time the CTD was deployed. Often multiple up and down profiles were made under a single cast number without removing the CTD from the water. The location of each CTD cast is given in Tables 6 and 7 for the deployment and recovery cruises respectively. The number of profiles within each cast is identified by “No. Drops”.

Table 6. Deployment Cruise CTD Log

Cruise	Cast No.	Station No.	No. Drops	Latitude	Longitude	date	time	water depth
Deployment	1		2	40 30.09	70 27.59	10-Jul	100	67
Deployment	2		1	40 30.24	70 27.06	10-Jul	133	66
Deployment	3		1	40 30.27	70 26.87	10-Jul	146	66
Deployment	4		2	40 30.30	70 26.67	10-Jul	201	65
Deployment	5		5	40 30.32	70 26.5	10-Jul	216	66
Deployment	6		5	40 30.31	70 26.35	10-Jul	232	65
Deployment	7		1	40 30.29	70 25.60	10-Jul	404	65
Deployment	8		1	40 30.28	70 25.57	10-Jul	416	65
Deployment	9		1	40 30.26	70 25.47	10-Jul	431	65
Deployment	10		1	40 30.23	70 25.38	10-Jul	445	65
Deployment	11		3	40 30.21	70 25.28	10-Jul	500	66
Deployment	12		1	40 30.21	70 25.22	10-Jul	515	65
Deployment	13		1	40 30.23	70 25.14	10-Jul	531	65
Deployment	14		1	40 30.26	70 25.08	10-Jul	545	65
Deployment	15		3	40 30.29	70 25.01	10-Jul	600	65
Deployment	16		1	40 30.32	70 24.93	10-Jul	615	65
Deployment	17		1	40 30.35	70 24.85	10-Jul	630	65
Deployment	18		3	40 30.40	70 24.80	10-Jul	645	65
Deployment	19		5	40 29.86	70 30.05	10-Jul	1856	68
Deployment	20	6	5	40 29.03	70 29.86	10-Jul	2205	69
Deployment	21	7	5	40 23.88	70 30.04	10-Jul	2308	80
Deployment	22	8	5	40 18.97	70 29.74	11-Jul	16	95
Deployment	23	9	5	40 13.93	70 29.96	11-Jul	132	115
Deployment	24	10	4	40 08.84	70 29.85	11-Jul	243	121
Deployment	25	11	3	40 03.89	70 29.96	11-Jul	353	180
Deployment	26	12	2	39 58.89	70 29.97	11-Jul	514	675
Deployment	27	13	2	39 53.92	70 29.95	11-Jul	618	1050
Deployment	28	12	2	39 58.95	70 30.20	11-Jul	737	625
Deployment	29	11	3	40 03.94	70 30.42	11-Jul	849	180
Deployment	30	10	3	40 08.92	70 29.97	11-Jul	1005	124
Deployment	31	9	3	40 14.05	70 30.14	11-Jul	1108	115
Deployment	32	8	3	40 19.14	70 30.15	11-Jul	1209	95
Deployment	33	7	3	40 23.08	70 30.07	11-Jul	1308	82.5

Table 6. Deployment Cruise CTD Log

Cruise	Cast No.	Station No.	No. Drops	Latitude	Longitude	date	time	water depth
Deployment	34	6	3	40 29.00	70 29.97	11-Jul	1407	68
Deployment	35	6	1	40 28.92	70 29.87	11-Jul	1432	70
Deployment	36	6	1	40 28.85	70 29.83	11-Jul	1447	69
Deployment	37	6	4	40 29.01	70 30.00	11-Jul	1501	69
Deployment	38	6	1	40 28.97	70 29.94	11-Jul	1517	69
Deployment	39	6	1	40 28.93	70 29.88	11-Jul	1530	69
Deployment	40		1	40 28.94	70 29.86	11-Jul	1545	69
Deployment	41		4	40 28.91	70 29.75	11-Jul	1601	69
Deployment	42	6	1	40 28.87	70 30.00	11-Jul	1637	70
Deployment	43	6	1	40 28.89	70 29.98	11-Jul	1645	70
Deployment	44	6	4	40 28.94	70 29.91	11-Jul	1700	69
Deployment	45	6	1	40 28.93	70 30.09	11-Jul	1736	69
Deployment	46	6	1	40 28.96	70 30.05	11-Jul	1745	69
Deployment	47	6	4	40 29.01	70 29.93	11-Jul	1800	69
Deployment	48		1	40 28.13	70 29.63	11-Jul	1830	70
Deployment	49		1	40 29.16	70 29.55	11-Jul	1846	70
Deployment	50		4	40 28.94	70 29.97	11-Jul	1903	70
Deployment	51		1	40 28.90	70 29.88	11-Jul	1932	70
Deployment	52		1	40 29.02	70 29.60	11-Jul	1948	70
Deployment	53		5	40 29.06	70 29.36	11-Jul	2002	70
Deployment	54		1	40 28.98	70 29.95	11-Jul	2033	70
Deployment	55		1	40 28.91	70 29.69	11-Jul	2046	70
Deployment	56		4	40 29.00	70 29.91	11-Jul	2101	70
Deployment	57		1	40 28.92	70 29.75	11-Jul	2135	70
Deployment	58		1	40 28.80	70 29.55	11-Jul	2145	69
Deployment	59		4	40 29.07	70 29.99	11-Jul	2201	69
Deployment	60		1	40 28.91	70 29.83	11-Jul	2232	69
Deployment	61		1	40 28.73	70 29.58	11-Jul	2246	70
Deployment	62	6	4	40 28.99	70 29.90	11-Jul	2304	69
Deployment	63		1	40 28.98	70 29.87	11-Jul	2335	69
Deployment	64		1	40 28.86	70 29.63	11-Jul	2346	70
Deployment	65		4	40 28.93	70 29.89	12-Jul	2	69
Deployment	66		1	40 28.97	70 30.05	12-Jul	34	69
Deployment	67		4	40 28.84	70 29.87	12-Jul	100	69

Table 6. Deployment Cruise CTD Log

Cruise	Cast No.	Station No.	No. Drops	Latitude	Longitude	date	time	water depth
Deployment	68	6	1	40 29.02	70 30.09	12-Jul	130	69
Deployment	69	6	1	40 28.95	70 30.06	12-Jul	145	69
Deployment	70	6	4	40 28.89	70 29.96	12-Jul	159	69
Deployment	71		1	40 29.00	70 30.00	12-Jul	231	69
Deployment	72		1	40 28.94	70 30.05	12-Jul	245	69
Deployment	73	6	4	40 28.90	70 30.14	12-Jul	259	69
Deployment	74	6	1	40 28.94	70 30.06	12-Jul	332	69
Deployment	75		1	40 28.90	70 30.17	12-Jul	345	69
Deployment	76	6	4	40 28.85	70 30.29	12-Jul	359	69
Deployment	77	6	1	40 28.90	70 30.19	12-Jul	435	69
Deployment	78	6	1	40 28.82	70 30.29	12-Jul	445	69
Deployment	79	6	4	40 28.72	70 30.45	12-Jul	500	70
Deployment	80	6	1	40 29.05	70 30.11	12-Jul	530	69
Deployment	81	6	1	40 29.70	70 30.35	12-Jul	545	69
Deployment	82	6	4	40 28.95	70 30.96	12-Jul	600	69
Deployment	83	5	5	40 34.06	70 30.16	12-Jul	700	62
Deployment	84	4	5	40 39.17	70 30.04	12-Jul	802	58
Deployment	85	3	5	40 44.06	70 30.05	12-Jul	904	53
Deployment	86	2	5	40 49.04	70 30.06	12-Jul	954	51
Deployment	87	1	5	40 54.11	70 29.94	12-Jul	1044	50

Table 7. Recovery Cruise CTD Log

Cruise	Cast No.	Station No.	No. Drops	Latitude	Longitude	date	time	water depth
Recovery	1	6	5	40 28.83	70 29.75	26-Sep	223	69
Recovery	2	5	5	40 33.98	70 29.95	26-Sep	344	62
Recovery	3	4	5	40 38.99	70 30.10	26-Sep	445	56
Recovery	4	3	5	40 43.95	70 30.13	26-Sep	545	54
Recovery	5	2	5	40 48.95	70 30.07	26-Sep	641	51
Recovery	6	1	5	40 53.96	70 30.05	26-Sep	739	48
Recovery	7	6	7	40 29.36	70 30.00	26-Sep	1033	69
Recovery	8	6	2	40 28.99	70 29.95	27-Sep	212	69
Recovery	9	7	2	40 23.95	70 30.11	27-Sep	306	80
Recovery	10	8	1	40 18.99	70 30.07	27-Sep	357	95
Recovery	11	9	1	40 14.06	70 30.04	27-Sep	451	115
Recovery	12	10	1	40 08.98	70 30.08	27-Sep	541	122
Recovery	13	11	1	40 04.00	70 30.08	27-Sep	633	180
Recovery	14	12	1	39 58.99	70 30.02	27-Sep	725	620
Recovery	15	12	1	39 58.98	70 30.16	27-Sep	753	620
Recovery	16	12	1	39 59.02	70 29.96	27-Sep	823	620
Recovery	17		1	40 16.60	70 30.16	27-Sep	1031	105
Recovery	18		1	40 17.16	70 30.79	27-Sep	1103	105
Recovery	19		1	40 17.16	70 30.96	27-Sep	1111	105
Recovery	21	8	2	40 19.18	70 30.13	28-Sep	8	95
Recovery	22	9	2	40 14.06	70 29.99	28-Sep	105	115
Recovery	23	10	1	40 09.02	70 30.03	28-Sep	201	122
Recovery	24	10	1	40 07.00	70 29.97	28-Sep	233	120
Recovery	25	10	1	40 09.38	70 29.96	28-Sep	304	122
Recovery	26	10	1	40 09.82	70 30.02	28-Sep	326	119
Recovery	27	9	1	40 14.23	70 30.07	28-Sep	414	112
Recovery	28	9	1	40 14.50	70 29.98	28-Sep	430	112
Recovery	29	9	1	40 14.79	70 30.04	28-Sep	444	112
Recovery	30	9	1	40 14.96	70 30.00	28-Sep	457	110
Recovery	31	6	4	40 28.98	70 30.06	28-Sep	640	69
Recovery	32	6	1	40 29.15	70 30.50	28-Sep	718	69
Recovery	33	6	1	40 29.00	70 30.00	28-Sep	732	69
Recovery	34	6	1	40 29.10	70 30.33	28-Sep	747	69
Recovery	35	6	2	40 29.19	70 30.46	28-Sep	805	69

Table 8. Day of Year Calendar for 1996

Convention used: Noon on January 1 is Day of Year 1.5

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
Day # 1	1	32	61	92	122	153	183	214	245	275	306	336	Day # 1
Day # 2	2	33	62	93	123	154	184	215	246	276	307	337	Day # 2
Day # 3	3	34	63	94	124	155	185	216	247	277	308	338	Day # 3
Day # 4	4	35	64	95	125	156	186	217	248	278	309	339	Day # 4
Day # 5	5	36	65	96	126	157	187	218	249	279	310	340	Day # 5
Day # 6	6	37	66	97	127	158	188	219	250	280	311	341	Day # 6
Day # 7	7	38	67	98	128	159	189	220	251	281	312	342	Day # 7
Day # 8	8	39	68	99	129	160	190	221	252	282	313	343	Day # 8
Day # 9	9	40	69	100	130	161	191	222	253	283	314	344	Day # 9
Day #10	10	41	70	101	131	162	192	223	254	284	315	345	Day #10
Day #11	11	42	71	102	132	163	193	224	255	285	316	346	Day #11
Day #12	12	43	72	103	133	164	194	225	256	286	317	347	Day #12
Day #13	13	44	73	104	134	165	195	226	257	287	318	348	Day #13
Day #14	14	45	74	105	135	166	196	227	258	288	319	349	Day #14
Day #15	15	46	75	106	136	167	197	228	259	289	320	350	Day #15
Day #16	16	47	76	107	137	168	198	229	260	290	321	351	Day #16
Day #17	17	48	77	108	138	169	199	230	261	291	322	352	Day #17
Day #18	18	49	78	109	139	170	200	231	262	292	323	353	Day #18
Day #19	19	50	79	110	140	171	201	232	263	293	324	354	Day #19
Day #20	20	51	80	111	141	172	202	233	264	294	325	355	Day #20
Day #21	21	52	81	112	142	173	203	234	265	295	326	356	Day #21
Day #22	22	53	82	113	143	174	204	235	266	296	327	357	Day #22
Day #23	23	54	83	114	144	175	205	236	267	297	328	358	Day #23
Day #24	24	55	84	115	145	176	206	237	268	298	329	359	Day #24
Day #25	25	56	85	116	146	177	207	238	269	299	330	360	Day #25
Day #26	26	57	86	117	147	178	208	239	270	300	331	361	Day #26
Day #27	27	58	87	118	148	179	209	240	271	301	332	362	Day #27
Day #28	28	59	88	119	149	180	210	241	272	302	333	363	Day #28
Day #29	29	60	89	120	150	181	211	242	273	303	334	364	Day #29
Day #30	30		90	121	151	182	212	243	274	304	335	365	Day #30
Day #31	31		91		152		213	244		305		366	Day #31

Figure 5a. Deployment Cruise CTD stations 1-13 (casts 87 86 85 84 83 82 33 32 31 30 29 28 27)

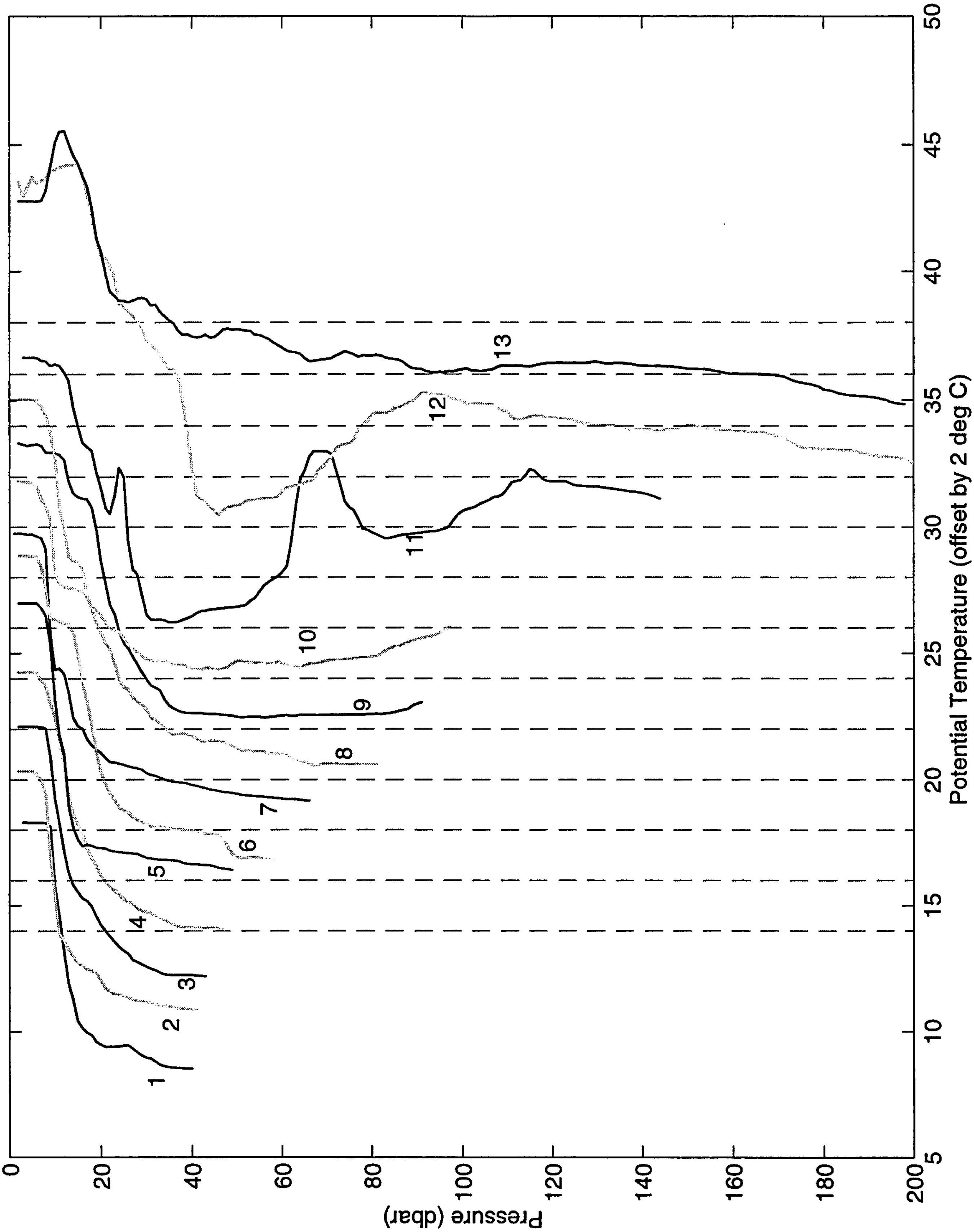


Figure 5b. Deployment Cruise CTD stations 1-13 (casts 87 86 85 84 83 82 33 32 31 30 29 28 27)

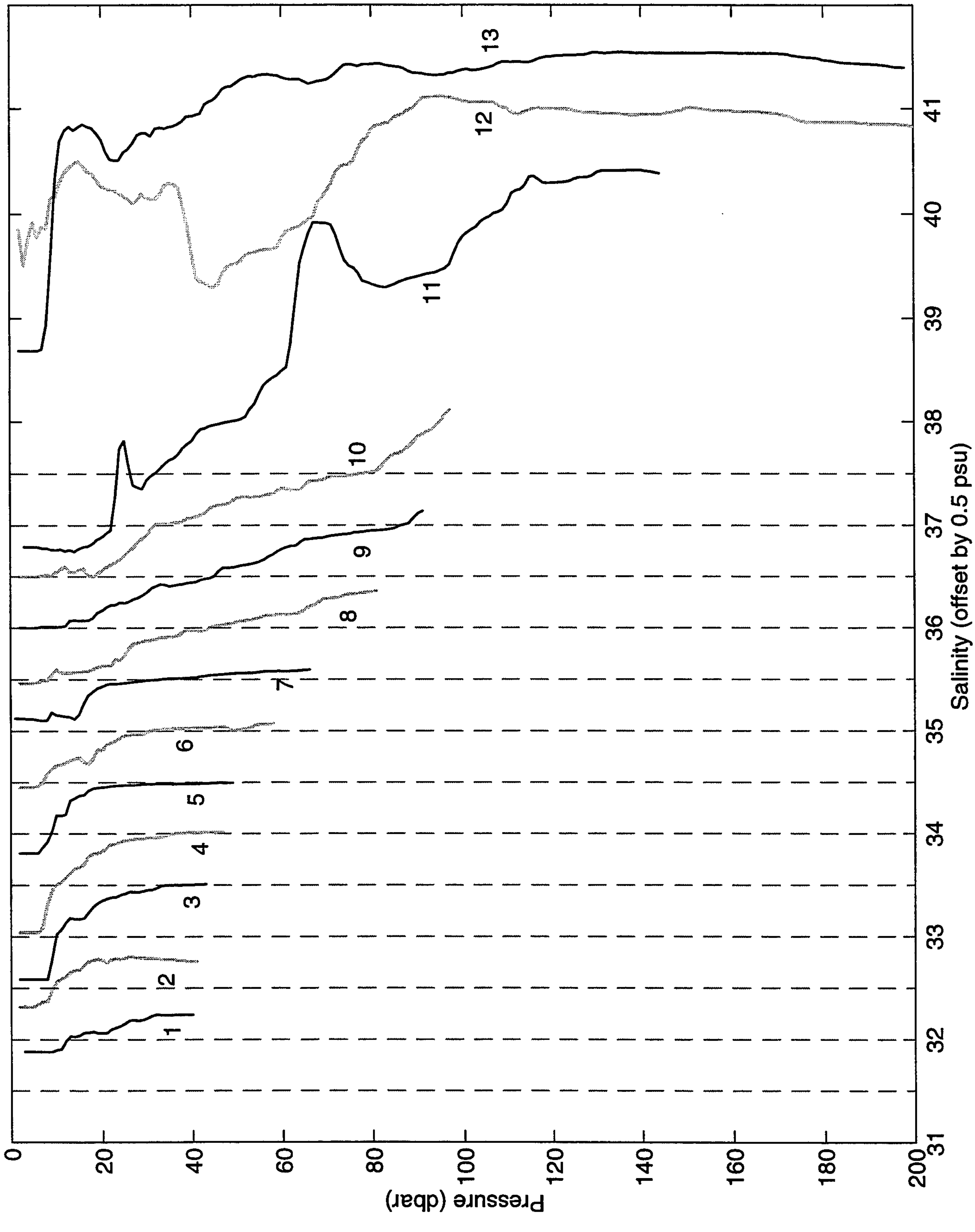
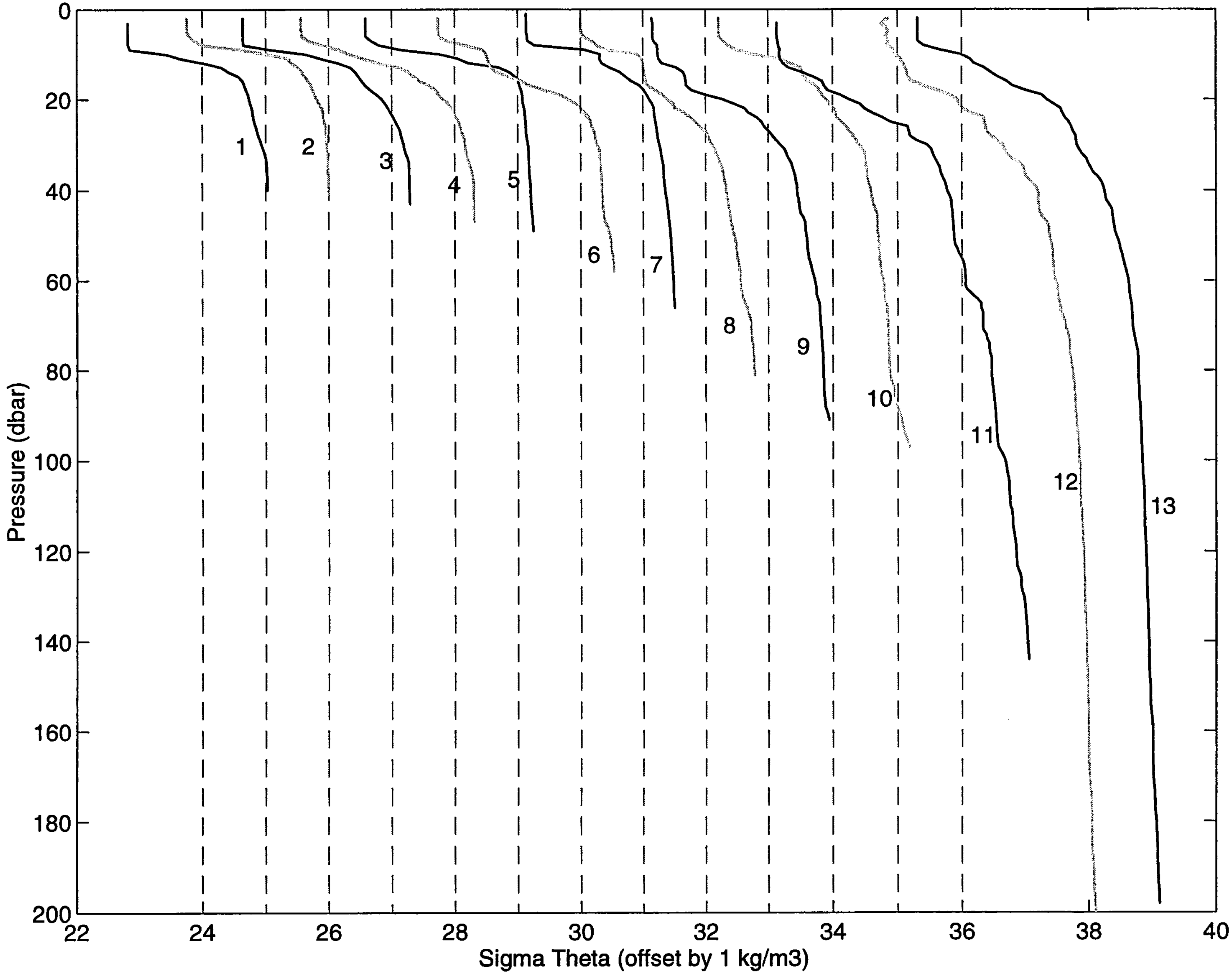


Figure 5c. Deployment Cruise CTD stations 1-13 (casts 87 86 85 84 83 82 33 32 31 30 29 28 27)



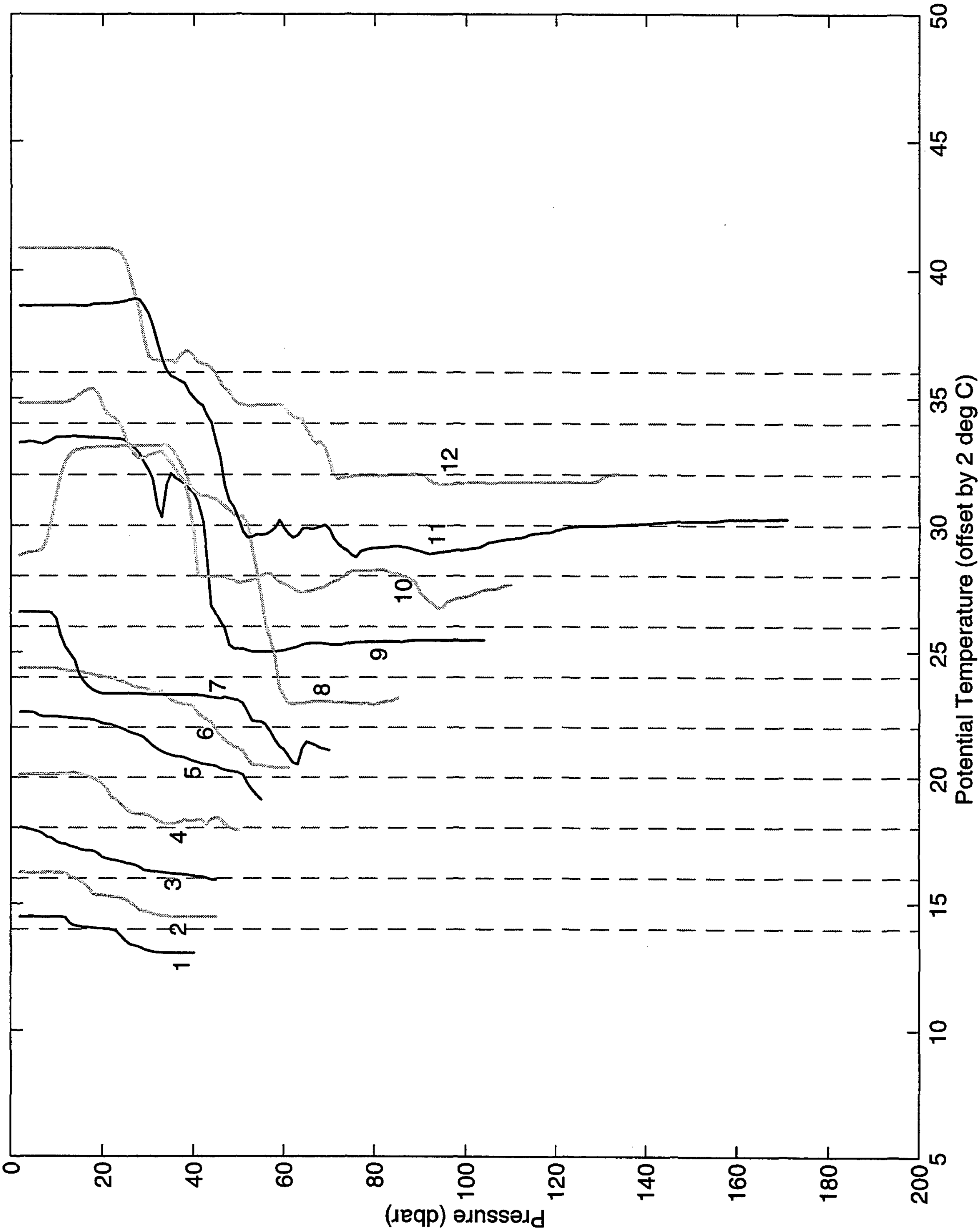


Figure 6a. Recovery Cruise CTD stations 1-12 (casts 6 5 4 3 2 1 9 10 11 12 13 14)

Figure 6b. Recovery Cruise CTD stations 1-12 (casts 6 5 4 3 2 1 9 10 11 12 13 14)

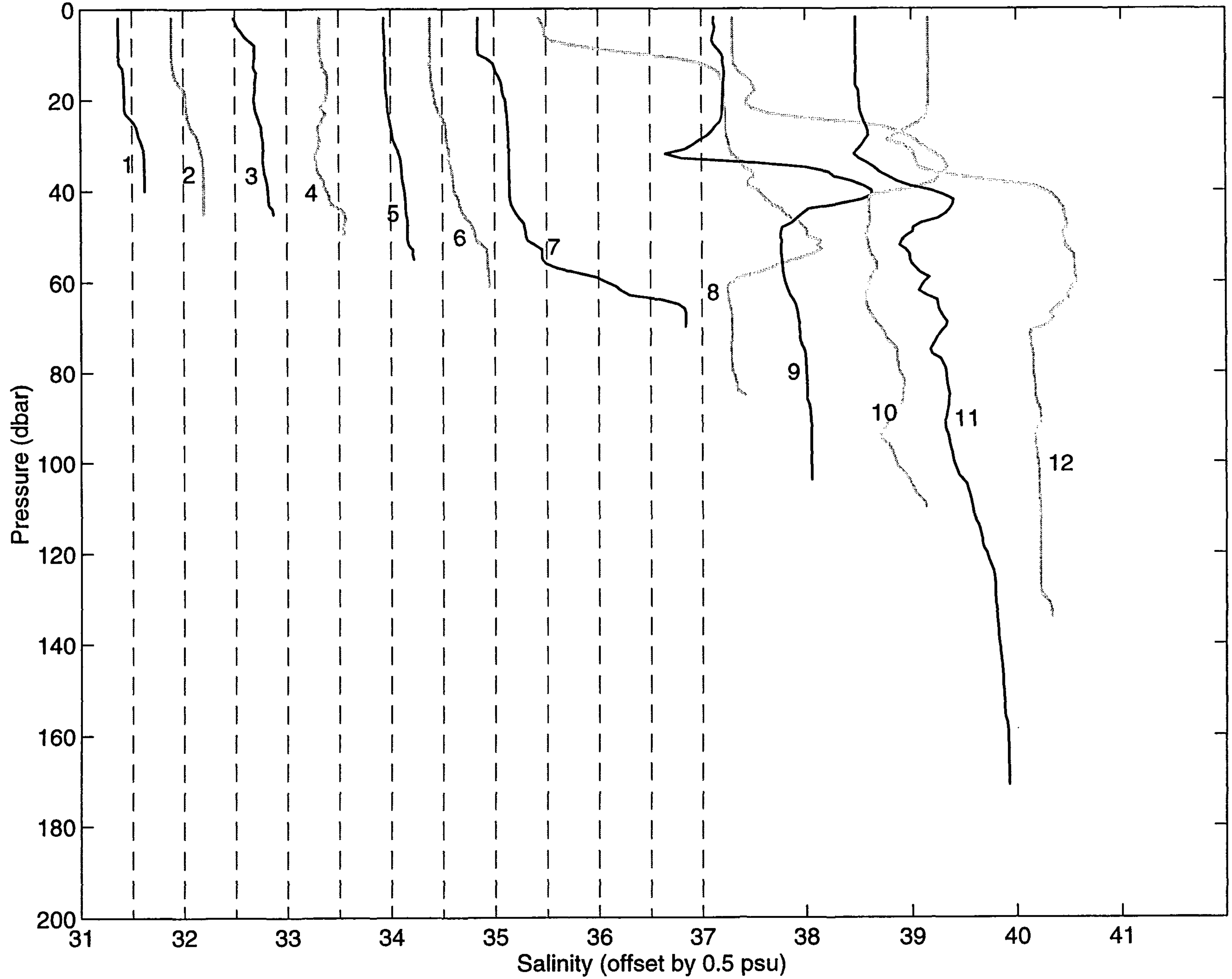
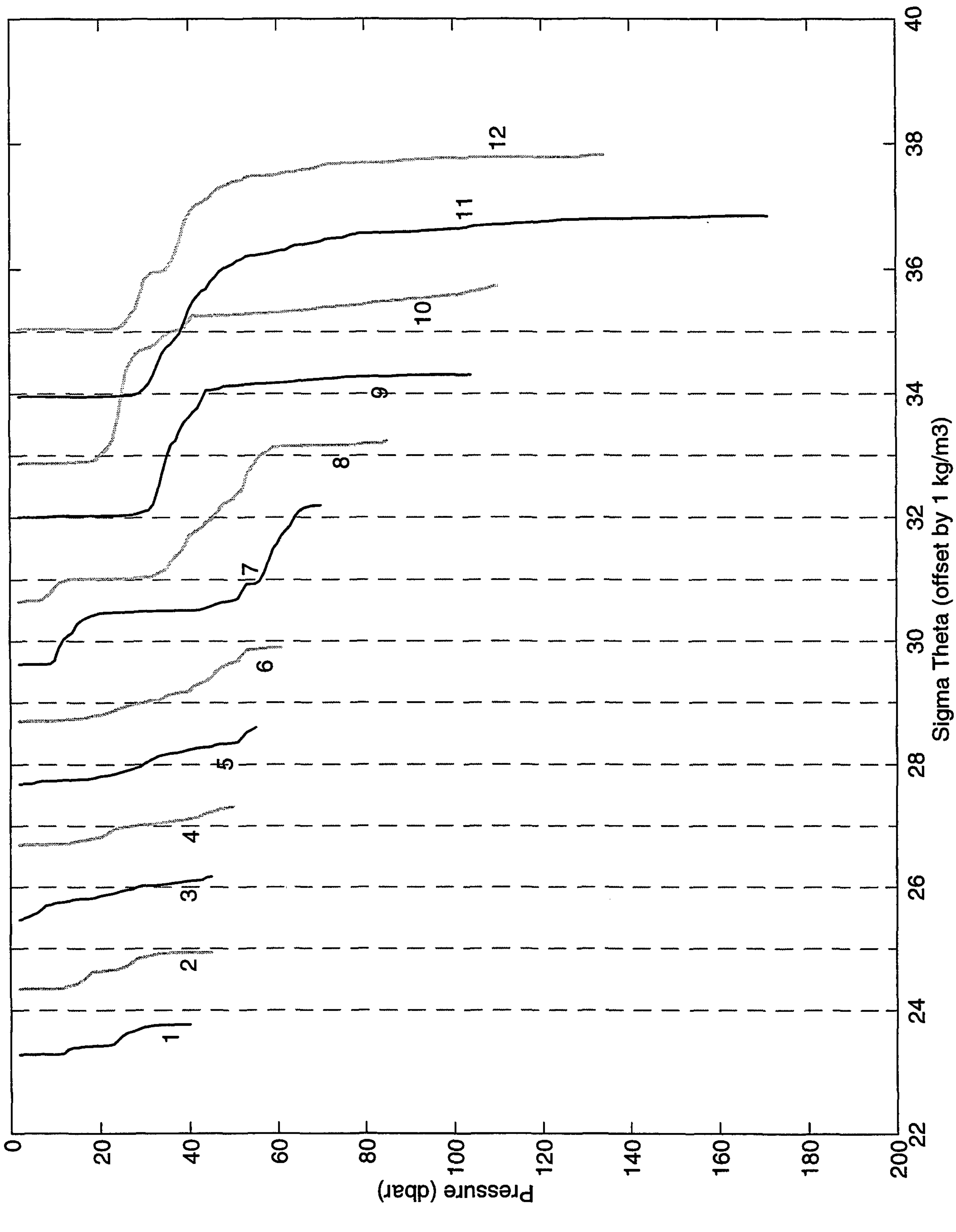


Figure 6c. Recovery Cruise CTD stations 1-12 (casts 6 5 4 3 2 1 9 10 11 12 13 14)



APPENDIX 1: DEPLOYMENT CRUISE REPORT

Deployment Cruise Report July 12, 1996

SAS PRIMER / Coastal Mixing & Optics (ONR-sponsored)

R/V Oceanus--Voyage #281 submitted by Murray Levine, Chief Scientist

I. Deployed moorings at the Central site -- 3 moorings were set along a 500 m line in a north-south direction (CENTRAL GUARD, OSU MAIN, AUXILLARY); 1 mooring (OSU MET) is 260 m to the west of AUXILLARY. (Figure of layout in ftp site.)

A. OSU MAIN-- 40 deg 29.50' N; 70 deg 30.46'W -- no scope
1. Taut subsurface mooring with tethered surface marker buoy (radar reflector & flashing light)
2. Instrumentation: Temperature recorders (15), T-C Seacats (5), Doppler profiler (RDI ADCP), Rotor current meters (2), Dickey's BIOPS (3), acoustic release

B. OSU MET-- 40 deg 29.37'N; 70 deg 30.64'W --max scope 70 m radius
1. Surface buoy with meteorological mast, radar reflector & flashing light
2. Instrumentation: Temperature recorders (5); Doppler profiler (Sontek ADP); Air temp, barometer, wind velocity, humidity, insolation, acoustic release

C. AUXILLARY-- 40 deg 29.38'N; 70 deg 30.46'W-- WHOI buoy – max scope 70 m radius
1. Surface buoy with radar reflector and flashing light
2. Instrumentation: Temperature recorders (5)

D. CENTRAL GUARD-- 40 deg 29.65'N; 70 deg 30.46'W --WHOI buoy-- max scope 70 m radius
1. Surface buoy with radar reflector and flashing light
2. Instrumentation: none

II. Vertical profiles with CTD (SBE 25) with transmissometer and fluorometer

A. North-south transect along 70 deg 30'W with sampling to 80% of depth or 200 m (A preliminary listing of these data will appear soon in the ftp site.)

Station	Latitude, N	Water depth, m
#1	40 deg 54'	51
#2	40 deg 49'	52
#3	40 deg 44'	54
#4	40 deg 39'	59
#5	40 deg 34'	63
#6	40 deg 29'	70
#7	40 deg 24'	80
#8	40 deg 19'	95
#9	40 deg 14'	115
#10	40 deg 09'	121
#11	40 deg 04'	180
#12	39 deg 59'	625
#13	39 deg 54'	1050

B. Time series at Central Site --profiles to 60 m
Start time: 1400 UT 7/11/96
Duration: 16 hours
Sampling: 1 cast every 15 minutes; additional casts at 5 and 10 minutes after the hour

III. Bathymetric survey--using lab PDR--around central site. About 10 north-south lines 1 km apart between shipping lanes. No surprises--flat, gentle slope.

IV. Auxillary data

A. Ship system-- 1 minute averages-- GPS (P-code) position, IMET (wind velocity, air temperature, barometric pressure, humidity, short wave radiation, precipitation), surface temperature and salinity, ship heading and speed

B. ADCP --(quality uncertain)

1. 150 kHz --Narrowband
2. 300 kHz --Broadband

Comments:

1. There is much lobster gear in the water. Possible configuration, according to the Captain:

* At one end-- a weighted nylon line is attached to a small rubber float and a hard float with a pole (6') with a radar reflector ("high flyer")
* At the other end-- a small rubber float (with or without "high flyer")
* In the middle-- maybe 50 lobster pots strung together with 3/4" poly line; separation between pots may be 100 feet; a lobster pot is about 3'x4'x5'

These strings of pots are typically deployed along isobaths and often along Loran lines. Pots are recovered and redeployed at least weekly(?); hence positions will change. We did snag a line and dragged a float under water while towing a mooring into position for launch; just before attempting to retrieve mooring, the line came free. (An example copied from the radar screen near the central site will be located soon in the ftp site). Note that radar returns from moorings could not be distinguished from the "high flyers".

2. Deployment operations went smoothly--OSU MAIN and OSU MET were deployed during daylight on 9 July; AUXILLARY and CENTRAL GUARD were set on 10 July. Weather was great--little wind, swell and sea; some rain and heavy fog on 9 July; clear on 10 July. Hurricane Bertha stayed far south. CTD operations took place between mooring deloyments at night and continuously from midday on 10 July until the morning of 12 July. We returned to WHOI Friday afternoon 12 July, one day early.

3. Description of water column (caution: written by scientists at sea)

Central site-- Upper layer--surface to 5 - 10 meters-- T=18.5 to 19.5 deg; S= 32 psu
Pycnocline--10 to 20 m-- Buoyancy frequency-- 15 to 25 cph
Below 25 m -- Buoyancy frequency-- 4 to 5 cph

Between stations #6 and #11 pycnocline depth varies in time / space between 10 and 20 m. Front near station #12 over slope.

4. Scientific party

OSU -- Murray Levine, Timothy Boyd, Jay Simpkins, Walt Waldorf, Kieran O'Driscoll, Jose de Bettencourt
UCSB -- Tommy Dickey, Derek Manov, David Sigurdson
Merchant Marine Academy -- David Lytkowski
SSSG Tech -- Laura Goepfert

APPENDIX 2: RECOVERY CRUISE REPORT

Recovery Cruise Report September 28, 1996

SAS PRIMER / Coastal Mixing & Optics (ONR-sponsored)

R/V Oceanus--Voyage #288 submitted by Murray Levine, Chief Scientist

The cruise was short, action-packed and successful. Five independent groups worked together to perform a variety of mooring operations:

Levine/Boyd--mooring recovery--CTD survey
Dickey--mooring deployment
Agrawal--tripod recovery and redeployment
Williams--tripod recovery
Lentz/Plueddemann--mooring resetting and maintenance

The success and good spirit of the cruise was in no small part due to the exceptional weather. The full lunar eclipse was an added bonus. Many thanks to the crew of the Oceanus for their professionalism, patience, and sense of humor.

I. Recovered Renegade Mooring -- Inshore Surface Toroid Mooring (Lentz)
  A. Tracked from Argos position--found at 2025 UT 25 Sept at 40 deg 23.75'N; 71 deg 37.34'W--about 50 n. miles from the Central site
  B. Entire mooring from the release up was recovered without incident
  C. Redeployed with new release--1515 UT 26 Sept at 40 deg 35.00'N; 70 deg 27.50' W
II. Recovered OSU MAIN-- 1740 UT 26 Sept -- 40 deg 29.50' N; 70 deg 30.46'W
  A. Taut subsurface mooring with tethered surface marker buoy (radar reflector & flashing light)
  B. Instrumentation: Temperature recorders (15), T-C Seacats (5), Doppler profiler (RDI ADCP), Rotor current meters (2), Dickey's BIOPS (3), acoustic release
III. Recovered OSU MET-- 1900 UT 26 Sept -- 40 deg 29.37'N; 70 deg 30.64'W
  A. Surface buoy with meteorological mast, radar reflector & flashing light
  B. Instrumentation: Temperature recorders (5); Doppler profiler (Sontek ADP); Air temp, barometer, wind velocity, humidity, insolation, acoustic release
IV. Deployed Sea Tex waverider buoy-- 2020 UT 26 Sept
  A. Reattached buoy to existing tether
V. Recovered Agrawal Tripod-- 2120 UT 26 Sept
VI. Recovered AUXILLARY-- 2245 UT 26 Sept -- 40 deg 29.38'N; 70 deg 30.46'W
  A. Surface buoy with radar reflector and flashing light
  B. Instrumentation: Temperature recorders (5)
VII. Deployed South Guard (central site)-1405 UT 27 Sep--40 deg 29.26'N; 70 deg 30.60'W
  A. Surface buoy with radar reflector and flashing light--no instrumentation; no release
VIII. Deployed Dickey Mooring-- 1540 UT 27 Sep -- 40 deg 29.37'N; 70 deg 30.50'W
  A. Subsurface mooring; no surface expression
  B. Instrumentation: BIOPS (3), Doppler Profiler (RDI), T-C Seacats (3), T-pods (11), release
  C. Flashing light on deployed mooring sighted evening of 27 Sept at 40 deg 29.319'N, 70 deg 30.557'W
IX. Deployed Fan Beam Doppler -- 1650 UT 27 Sep -- 40 deg 29.50'N; 70 deg 30.60'W
  A. Subsurface float with ADCP inside; no surface expression
X. Recover Williams/Trowbridge Tripod-- 2200 UT 27 Sept

A. Line broke on first attempt
B. Second line required skilled handling to bring aboard--muddy feet
C. Instrumentation: BASS (Benthic Acoustic Stress Sensors) (7), T-C SeaBird (2), Acoustic Doppler Velocimeters (3) (Sontek), camera

XI. Deploy Agrawal Tripod -- 2230 UT 27 Sept--40 deg 29.32'N; 70 deg 30.32'W
A. Instrumentation: Floc camera assembly (P. Hill), LISST-100 (Laser In-Situ Scattering Transmissometry; Sequoia Scientific; C. Pottsmith, Y. Agrawal), BIOPS (T. Dickey)

XII. Miscellaneous Tasks
A. Visual check of Central Discus buoy with met station
B. Visited Offshore Toroid met station and replaced propeller assembly
C. Collected water samples before leaving the area--Dickey

XIII. Vertical profiles with CTD (SBE 25) with transmissometer
A. North-south transect along 70 deg 30'W with sampling to 80% of depth or 200 m

Station	Latitude, N	Water depth, m
#1	40 deg 54'	51
#2	40 deg 49'	52
#3	40 deg 44'	54
#4	40 deg 39'	59
#5	40 deg 34'	63
#6	40 deg 29'	70
#7	40 deg 24'	80
#8	40 deg 19'	95
#9	40 deg 14'	115
#10	40 deg 09'	121
#11	40 deg 04'	180
#12	39 deg 59'	625
#13	39 deg 54'	1050

B. Closely spaced casts around fronts between stations #7 and #12.

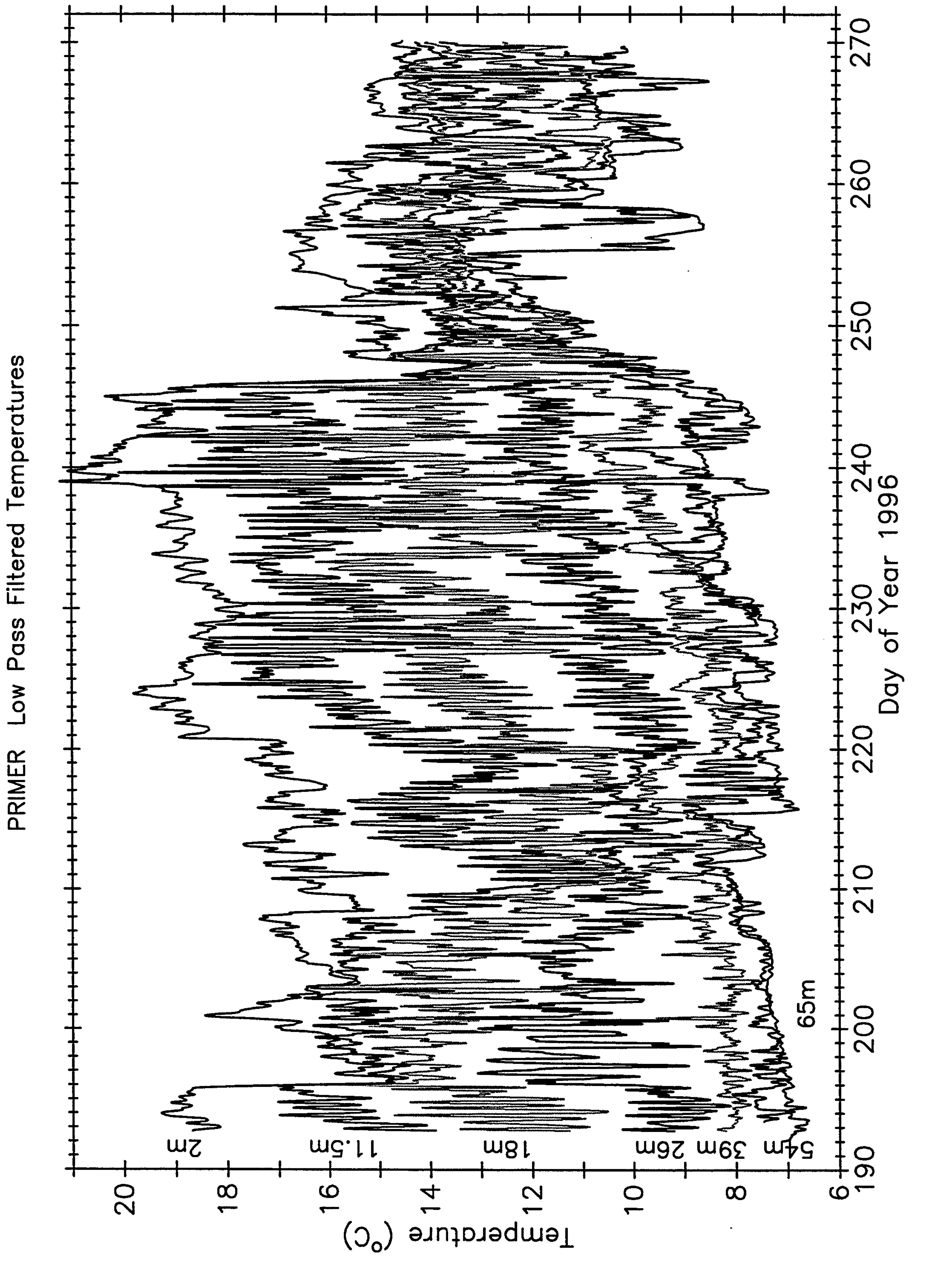
XIV. Scientific Party
OSU -- Murray Levine, Timothy Boyd, Walt Waldorf, Kieran O'Driscoll, Jose de Bettencourt
UCSB -- Tommy Dickey, Derek Manov, Joseph McNeil
WHOI -- William Ostrom, Bryan Way, Allan Gordon, Gary Stanbrough
Dalhousie -- Paul Hill
Sequoia -- Charles Pottsmith
SSSG Tech -- Erich Horgan

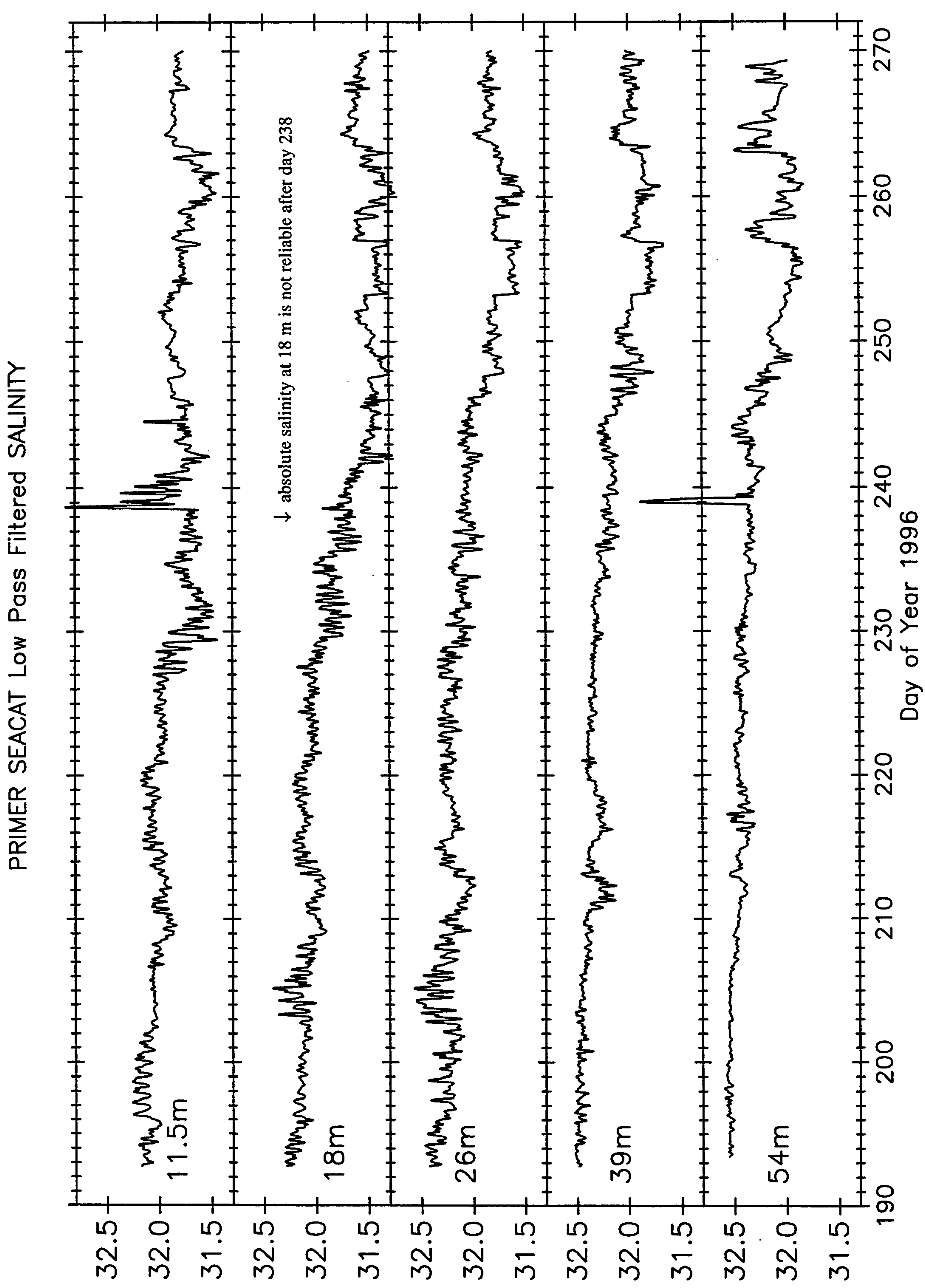
TEMPERATURE and SALINITY Time Series

Main Mooring

Low-pass Filtered

Temperature from Seacats deployed on the Main mooring at depths 11.5 m, 18 m, 26 m, 39 m, and 54 m, as well as temperature from MTR #3113 at 65 m on the Main mooring and MTR #3090 at 2 m on the Met mooring. Salinity from Seacats deployed on the Main mooring at depths 11.5 m, 18 m, 26 m, 39 m, and 54 m. The low-pass filter reduces energy at periods shorter than 5 hours. Note that the calibration of the Seacat at 18 m shifted relative to the Seacats at 11 m and 26 m on day 238. Absolute salinity at 18 m is not reliable after day 238.


PRIMER Low Pass Filtered Temperatures
Temperature (°C)
Day of Year 1996
2m
11.5m
18m
26m
39m
54m
65m
6
8
10
12
14
16
18
20
190
200
210
220
230
240
250
260
270

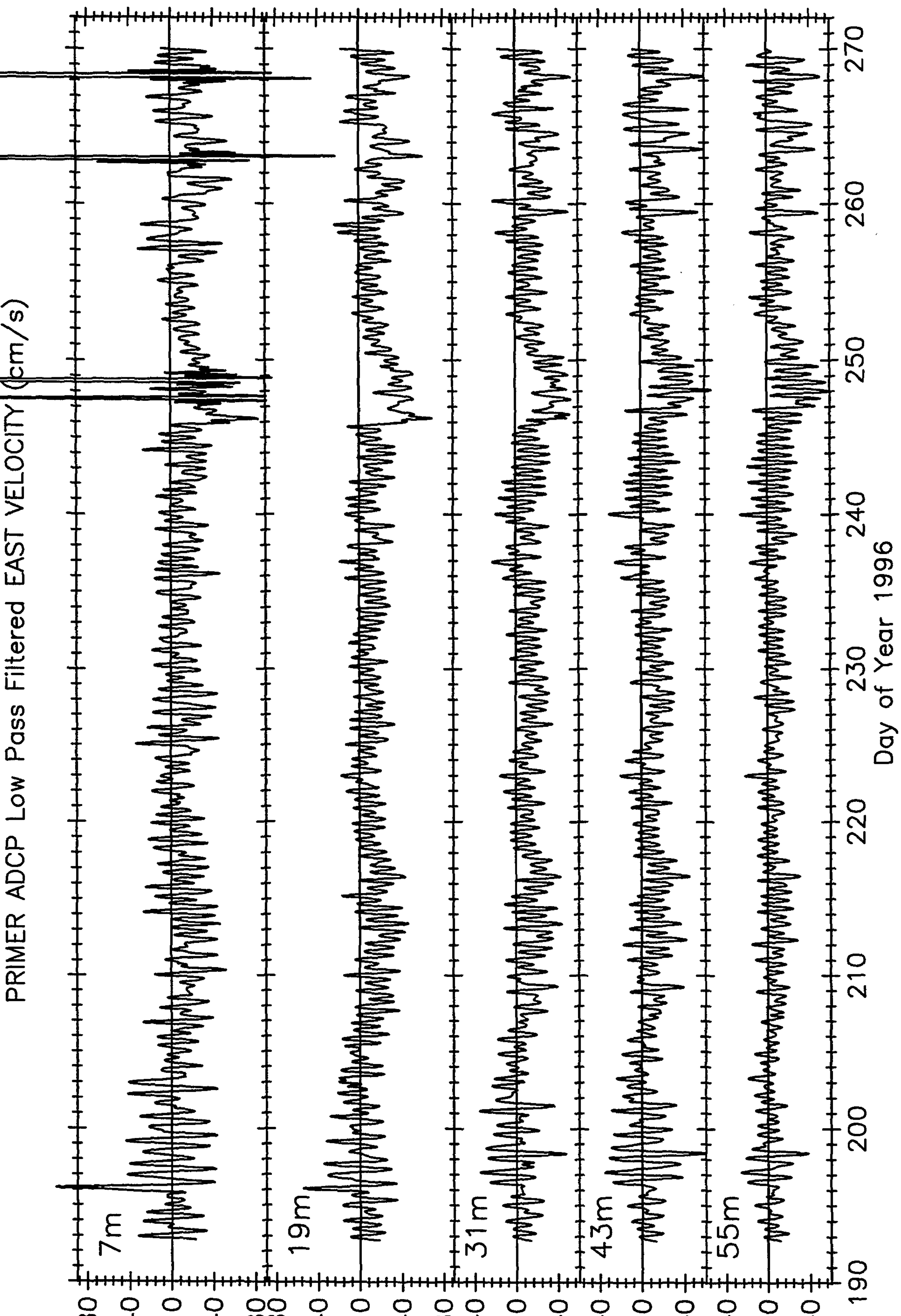

PRIMER SEACAT Low Pass Filtered SALINITY
11.5m
18m
26m
39m
54m
↓ absolute salinity at 18 m is not reliable after day 238
32.5
32.0
31.5
190
200
210
220
230
240
250
260
270
Day of Year 1996

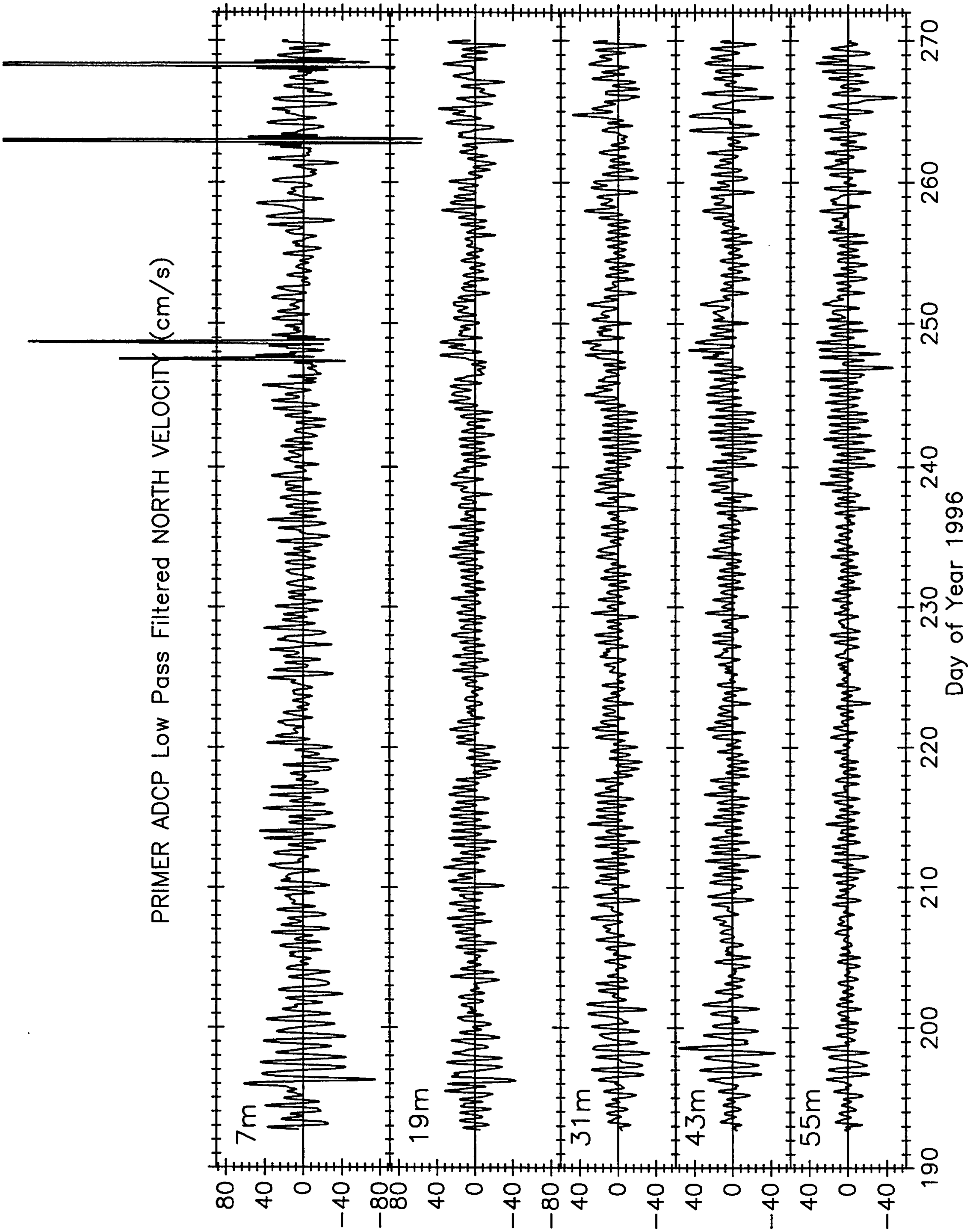
VELOCITY (ADCP) Time Series

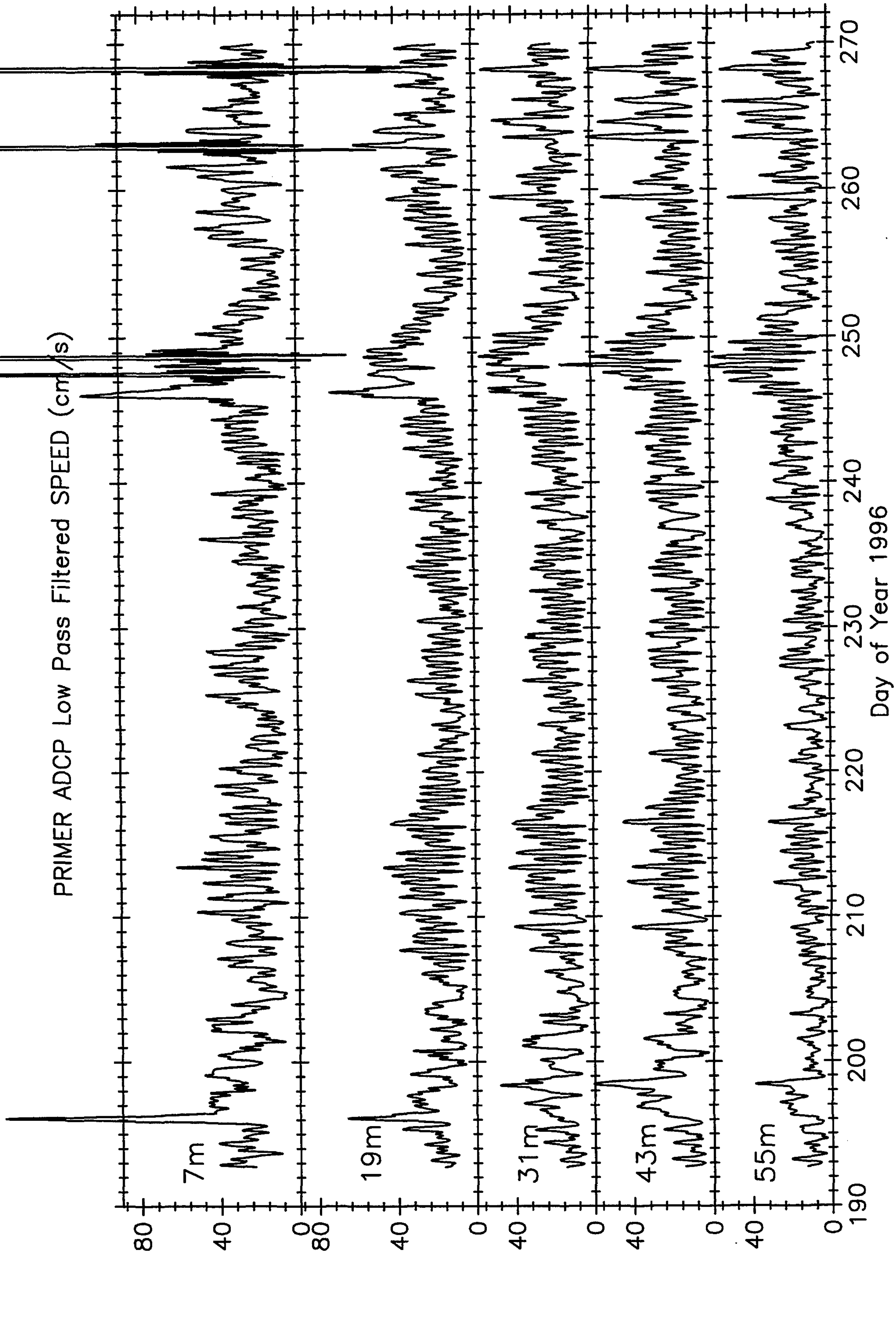
Main Mooring

Low-pass Filtered

ADCP east and north components of velocity and speed from 4-meter bins centered at 7 m, 19 m, 31 m, 43 m, and 55 m on the Main mooring. The low-pass filter reduces energy at periods shorter than 5 hours.


PRIMER ADCP Low Pass Filtered EAST VELOCITY (cm/s)
7m
19m
31m
43m
55m
80
40
0
−40
−80
Day of Year 1996
190
200
210
220
230
240
250
260
270


PRIMER ADCP Low Pass Filtered NORTH VELOCITY (cm/s)
7m
19m
31m
43m
55m
80
40
0
−40
−80
190
200
210
220
230
240
250
260
270
Day of Year 1996

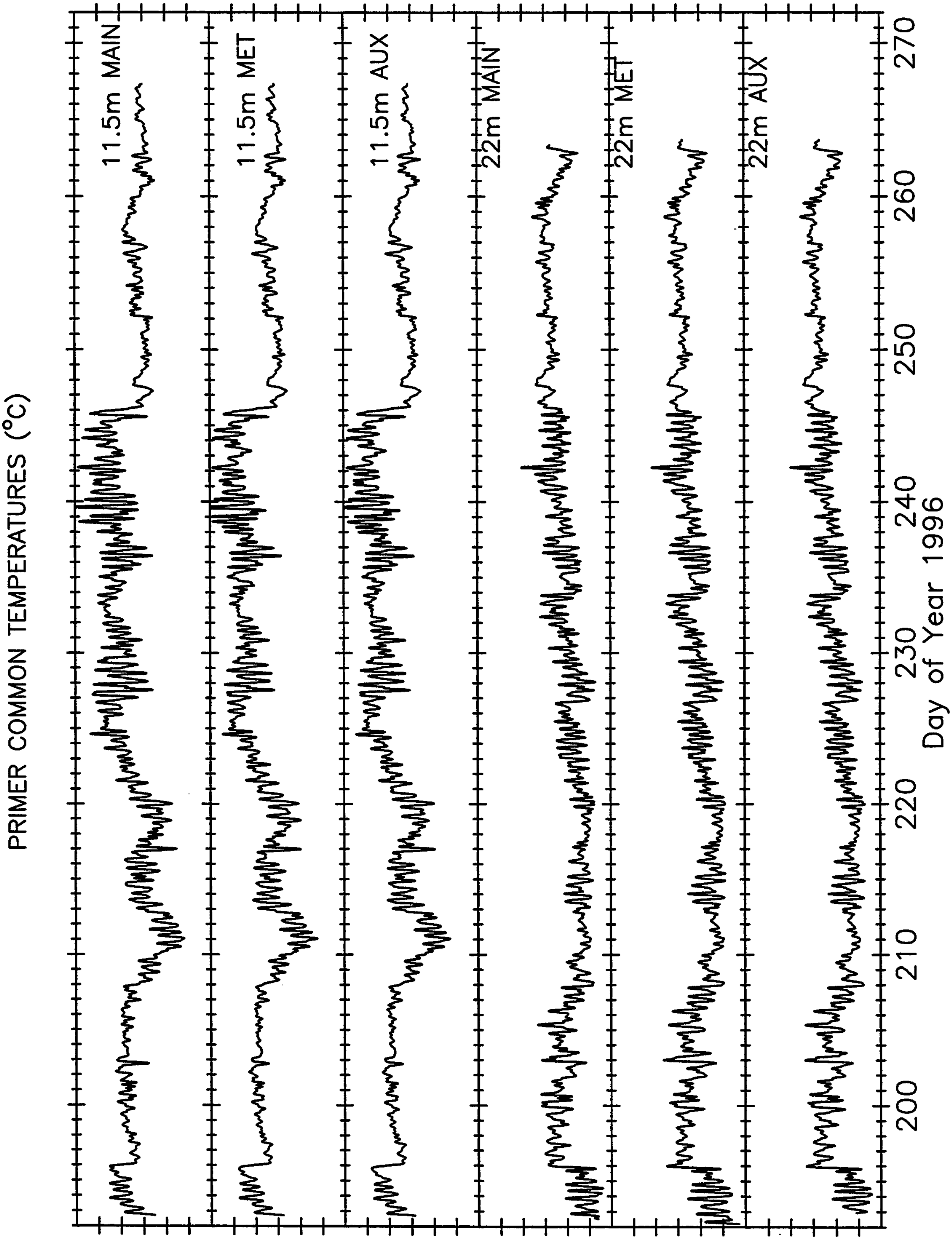

PRIMER ADCP Low Pass Filtered SPEED (cm/s)
7m
19m
31m
43m
55m
80
40
0
190
200
210
220
230
240
250
260
270
Day of Year 1996

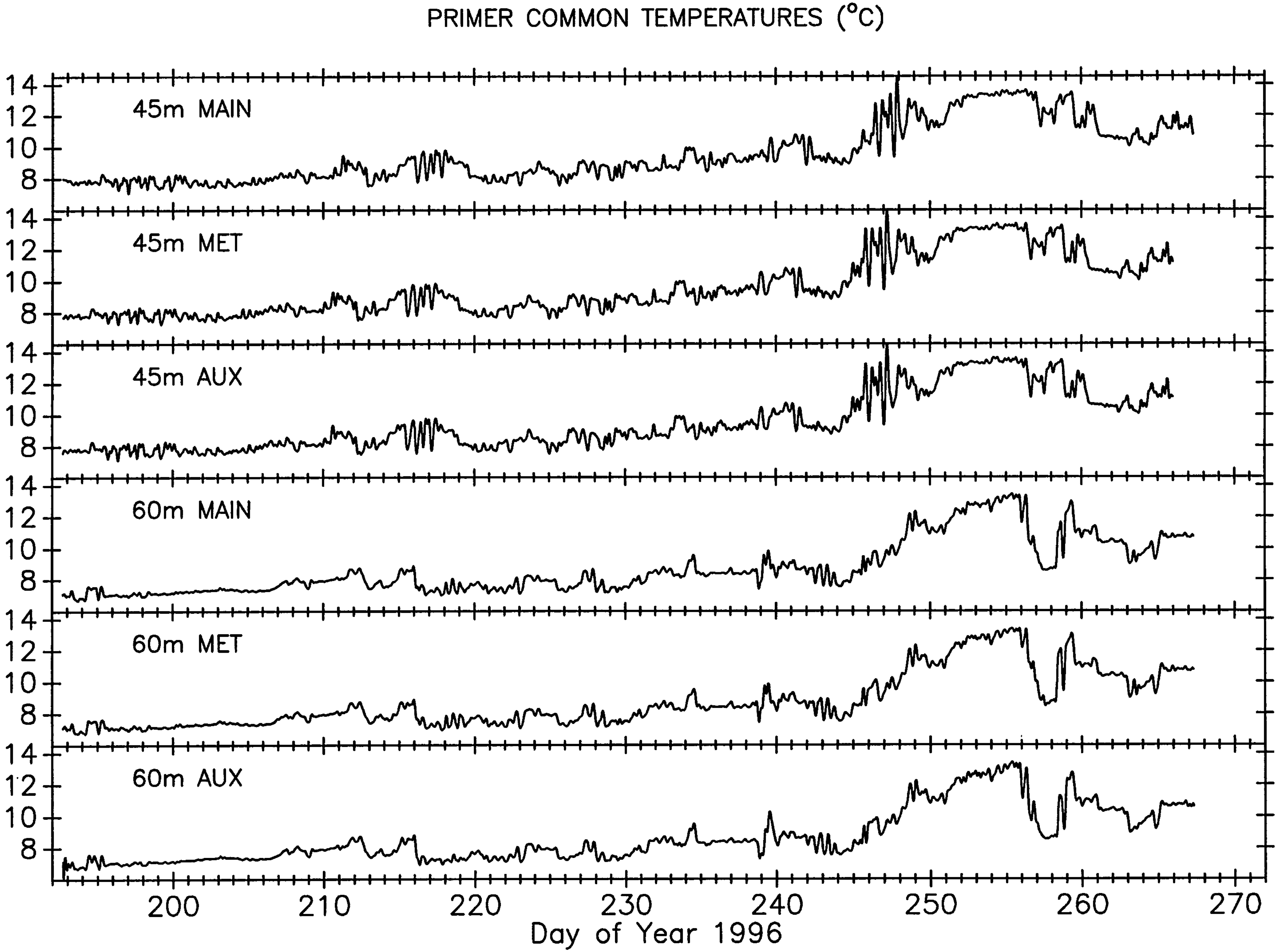
TEMPERATURE Time Series

Main, Met, and Aux Moorings: 11.5 m, 22 m, 45 m, 60 m

Low-Pass Filtered

Temperature from instruments deployed at the same depths on the Main, Met, and Aux moorings: 11.5 m, 22 m, 45 m, 55 m. Consult Tables 1-3 for the instrument types and serial numbers. The low-pass filter reduces energy at periods shorter than 5 hours.


PRIMER COMMON TEMPERATURES (°C)
11.5m MAIN
11.5m MET
11.5m AUX
22m MAIN
22m MET
22m AUX
18
16
14
12
10
200
210
220
230
240
250
260
270
Day of Year 1996

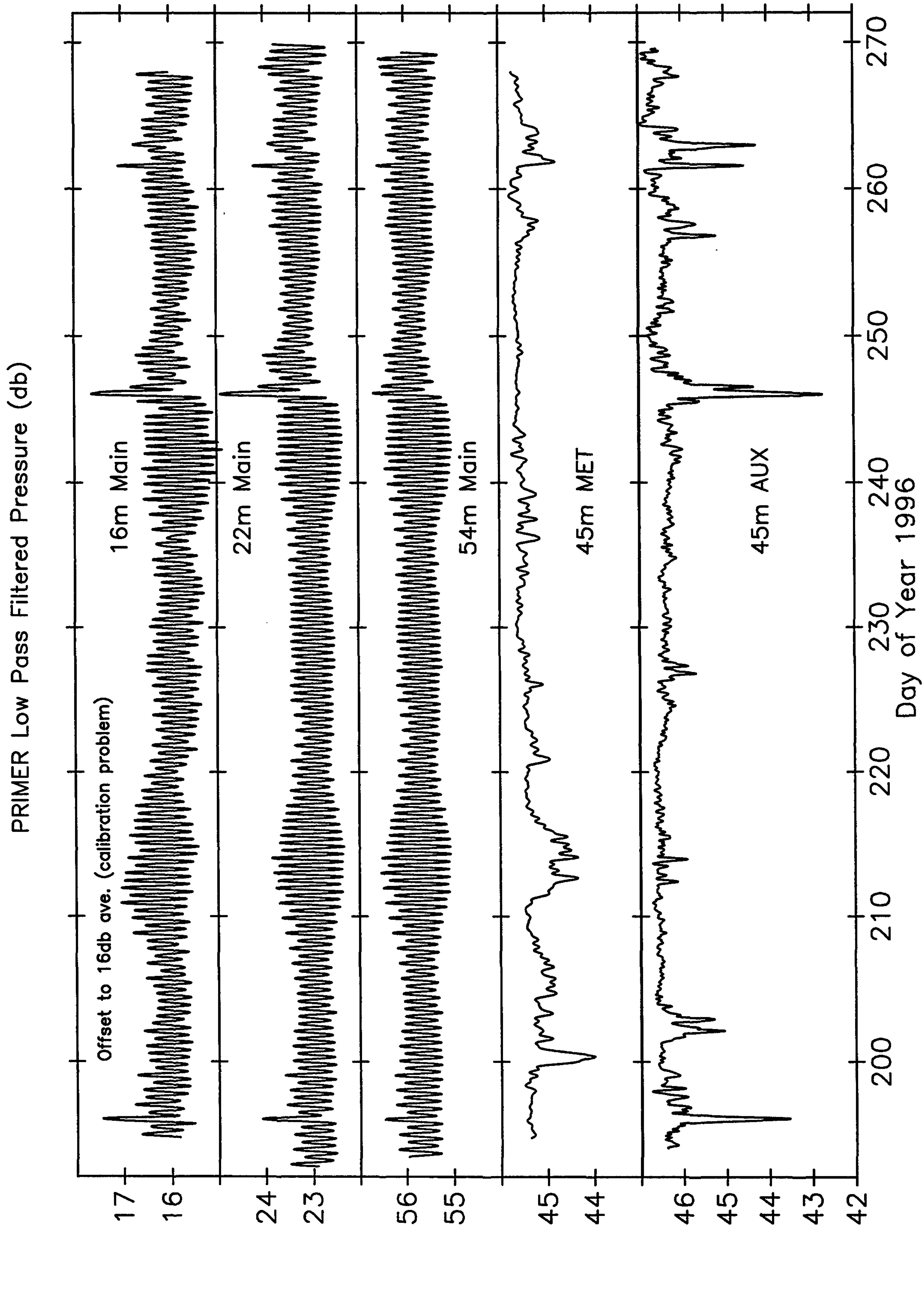

PRIMER COMMON TEMPERATURES (°C)
45m MAIN
45m MET
45m AUX
60m MAIN
60m MET
60m AUX
14
12
10
8
200
210
220
230
240
250
260
270
Day of Year 1996

PRESSURE Time Series

Main, Met, and Aux Moorings

Low-pass Filtered

Pressure from instruments deployed on the Main, Met, and Aux moorings: 16 m, 22 m, and 54 m on the Main mooring, and 45 m on the Met and Aux moorings. Consult Tables 1-3 for the instrument types and serial numbers. The low-pass filter reduces energy at periods shorter than 5 hours.



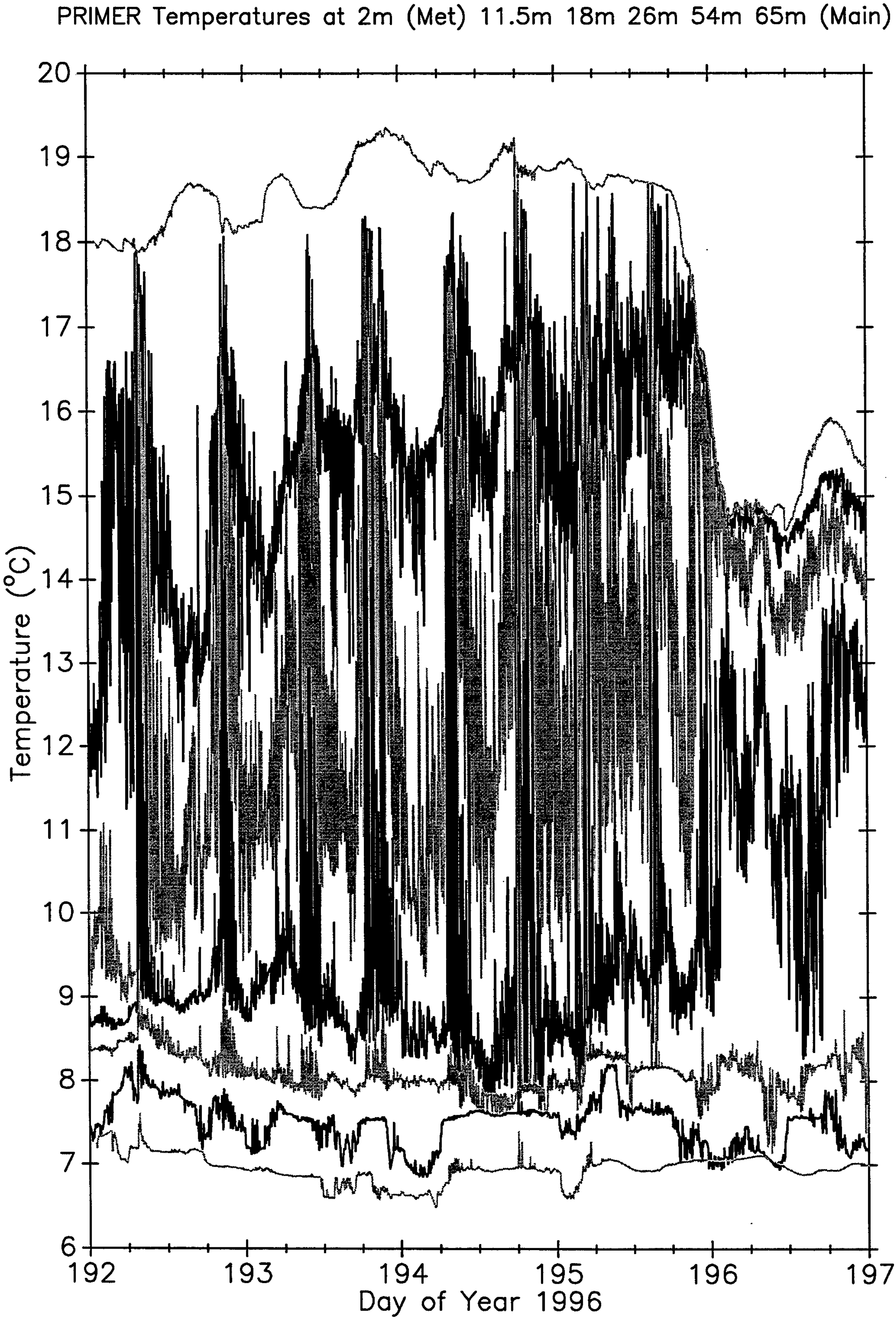
PRIMER Low Pass Filtered Pressure (db)
Offset to 16db ave. (calibration problem)
16m Main
22m Main
54m Main
45m MET
45m AUX
Day of Year 1996
200
210
220
230
240
250
260
270
17
16
24
23
56
55
45
44
46
45
44
43
42

TEMPERATURE Time Series

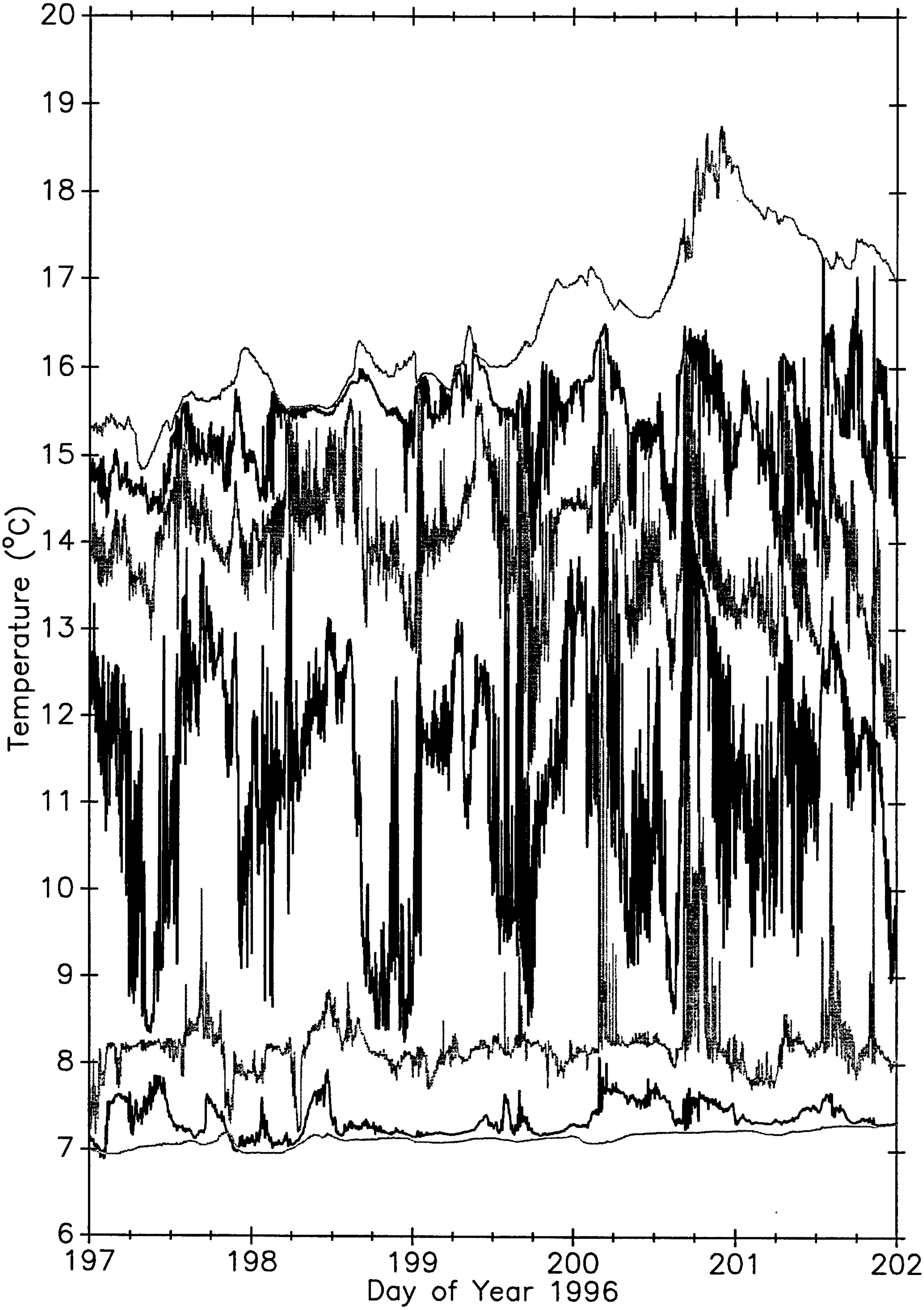
Main Mooring

Unfiltered

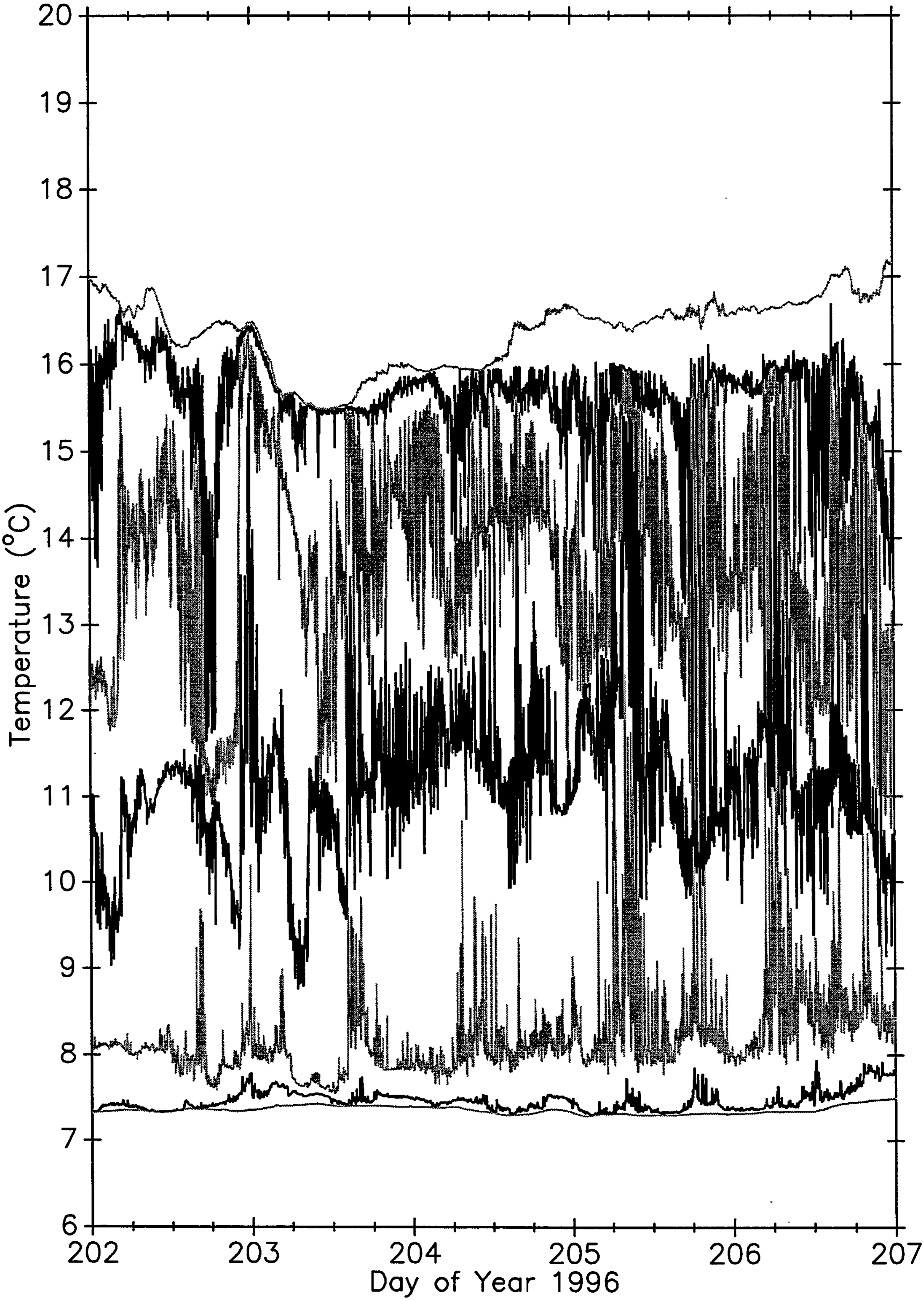
Temperature from Seacats deployed on the Main mooring at depths 11.5 m, 18 m, 26 m, 39 m, and 54 m, as well as temperature from MTR #3113 at 65 m on the Main mooring and MTR #3090 at 2 m on the Met mooring. Temperatures are not filtered. Sampling rates are shown in Tables 1-3.

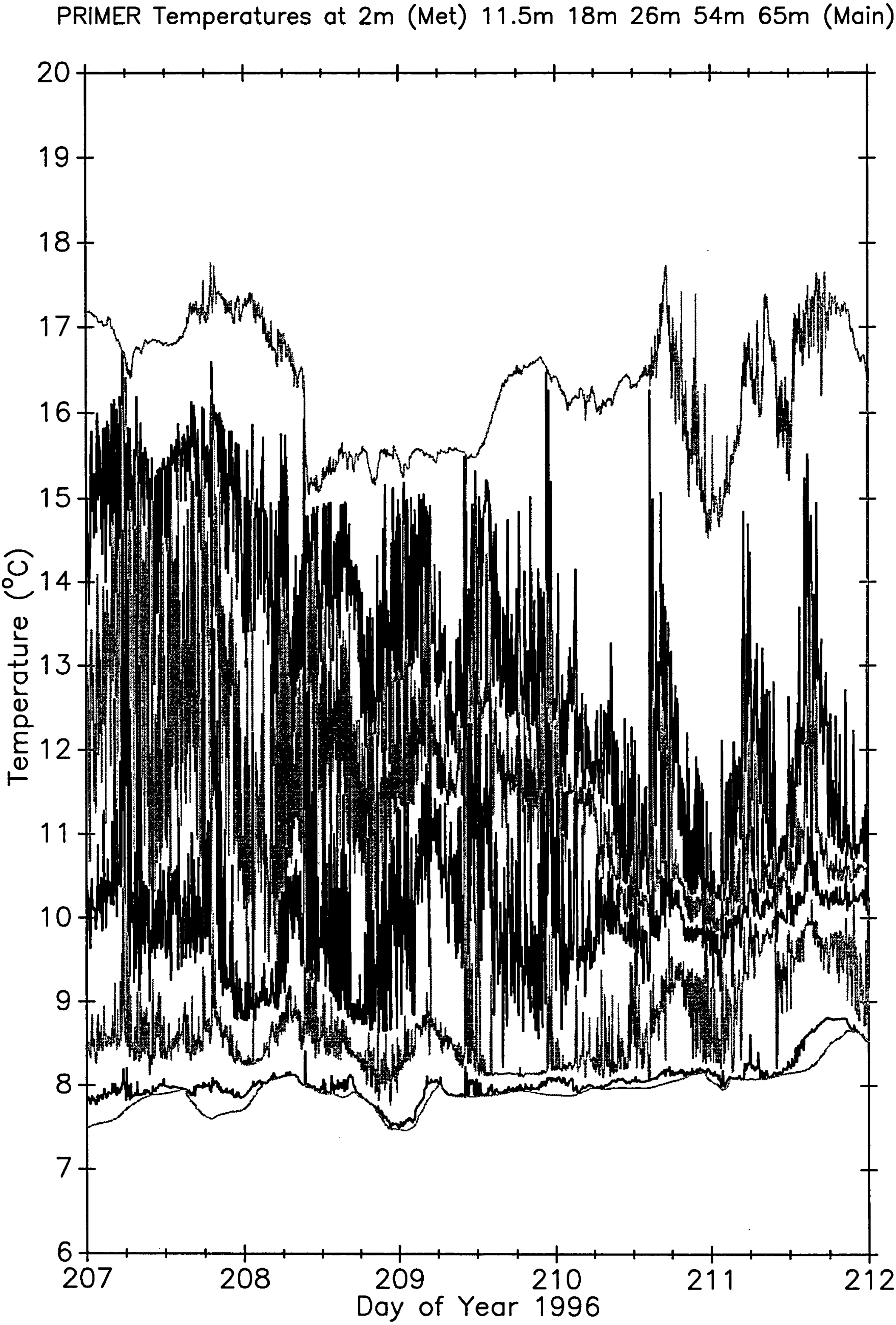

PRIMER Temperatures at 2m (Met) 11.5m 18m 26m 54m 65m (Main)
Temperature (°C)
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
192
193
194
195
196
197
Day of Year 1996

PRIMER Temperatures at 2m (Met) 11.5m 18m 26m 54m 65m (Main)



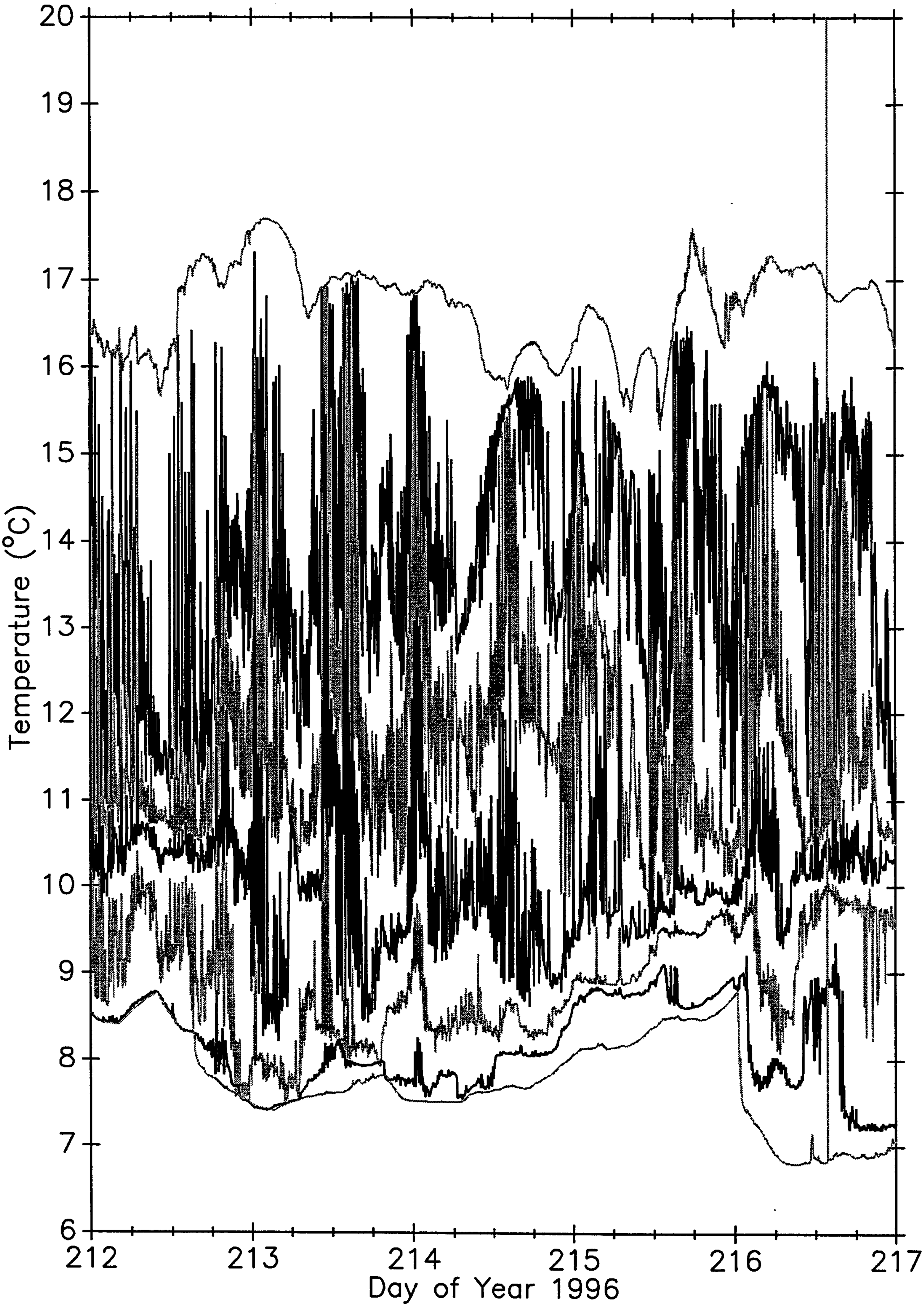
PRIMER Temperatures at 2m (Met) 11.5m 18m 26m 54m 65m (Main)

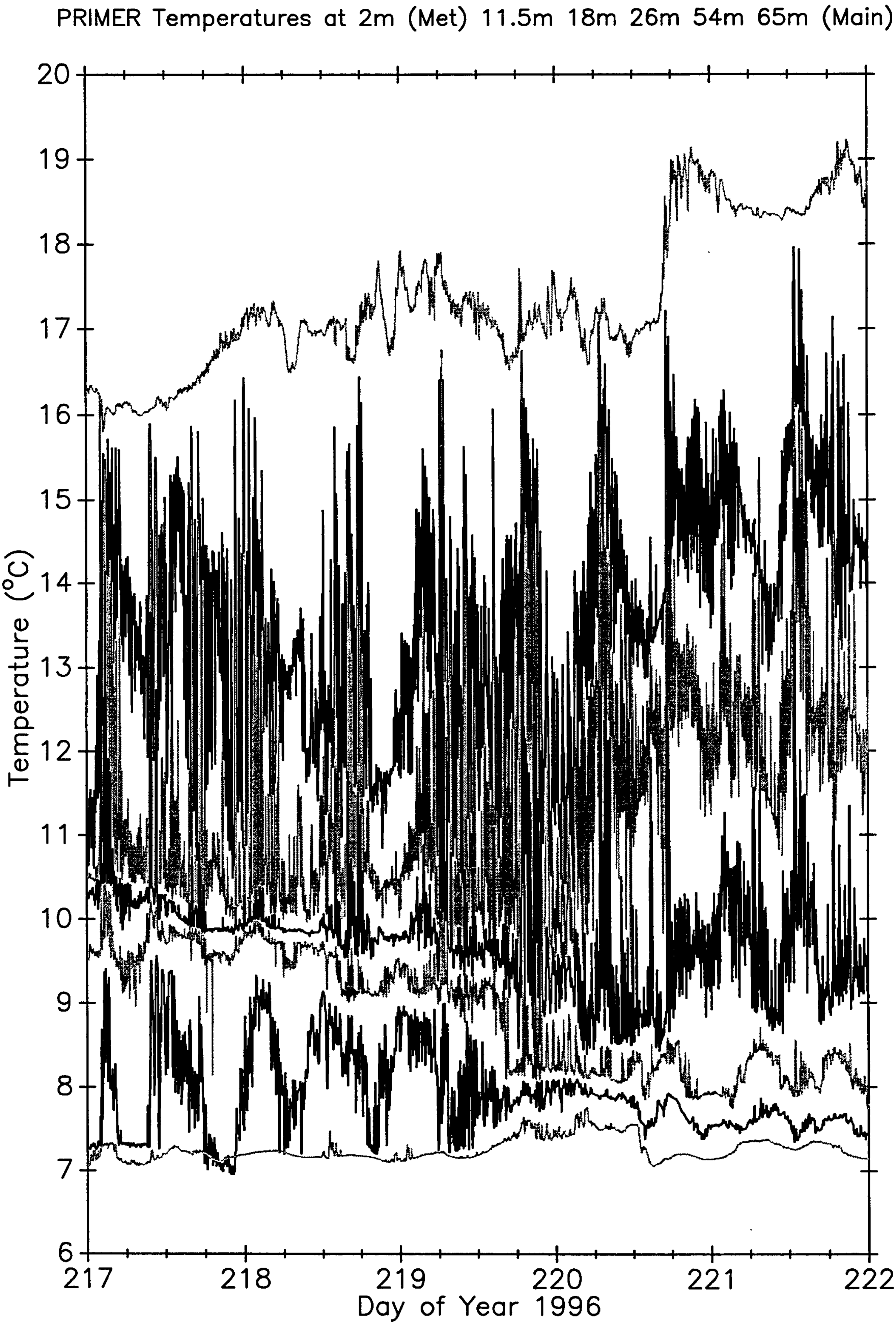


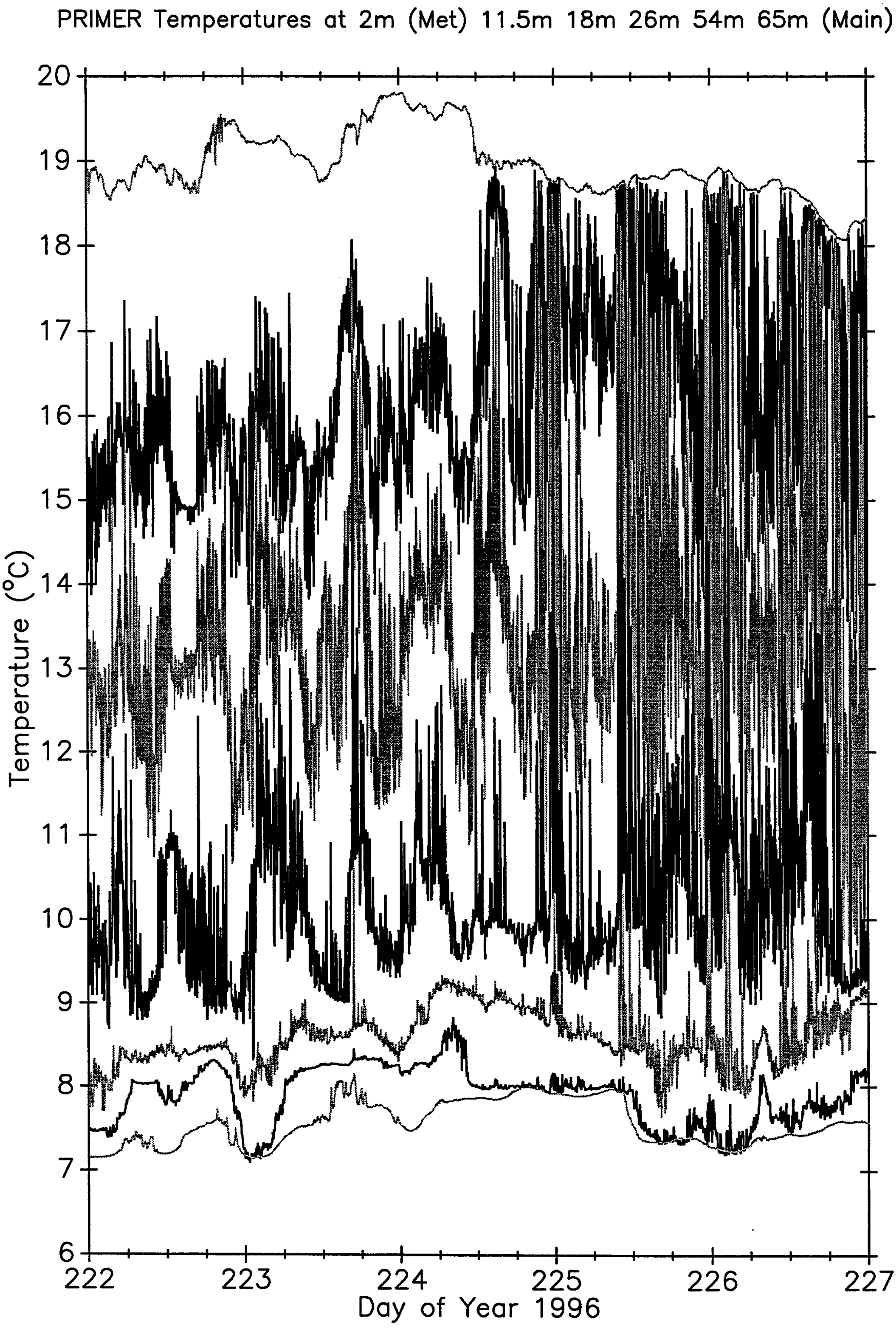


PRIMER Temperatures at 2m (Met) 11.5m 18m 26m 54m 65m (Main)
Temperature (°C)
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
207
208
209
210
211
212
Day of Year 1996

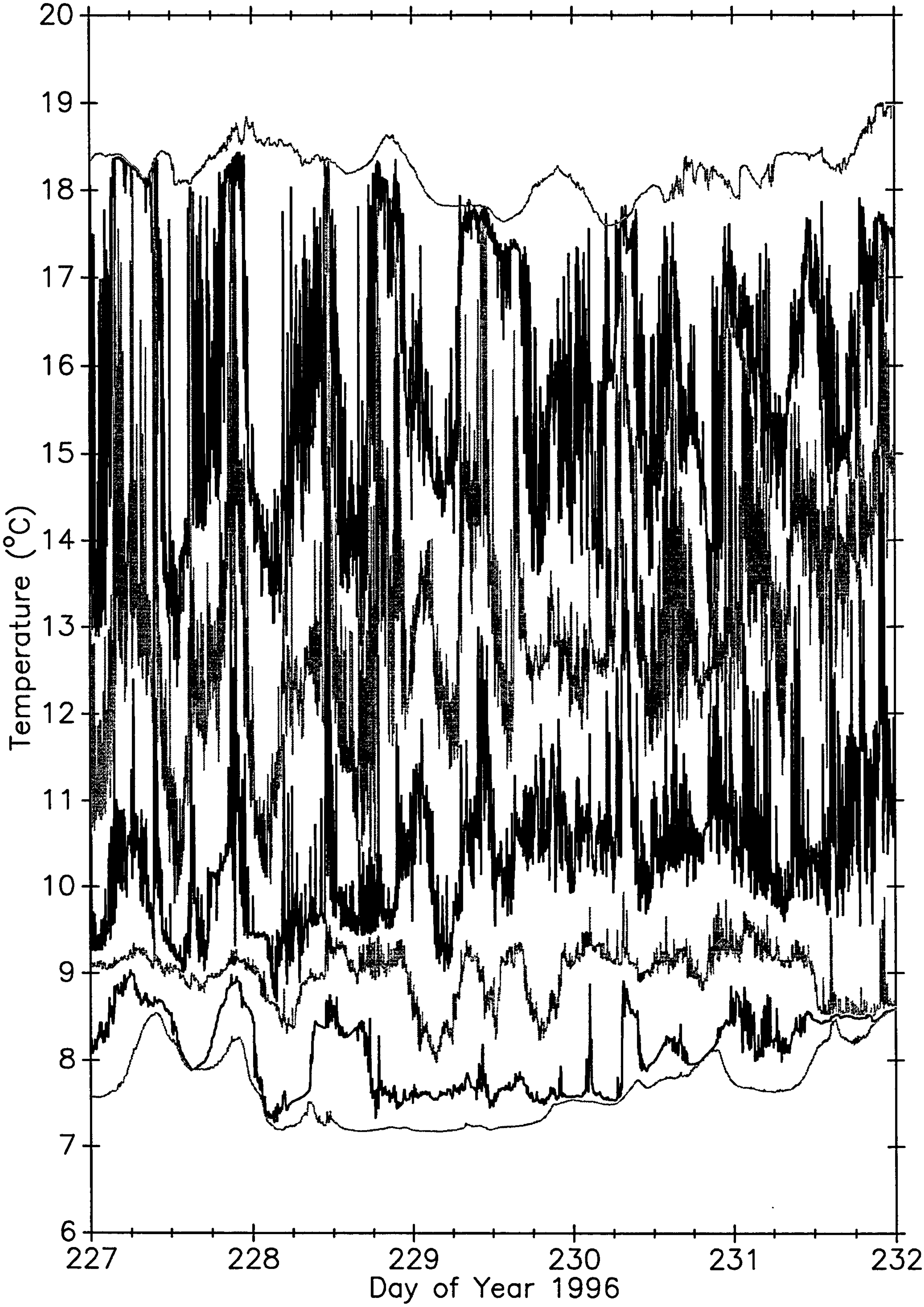
PRIMER Temperatures at 2m (Met) 11.5m 18m 26m 54m 65m (Main)



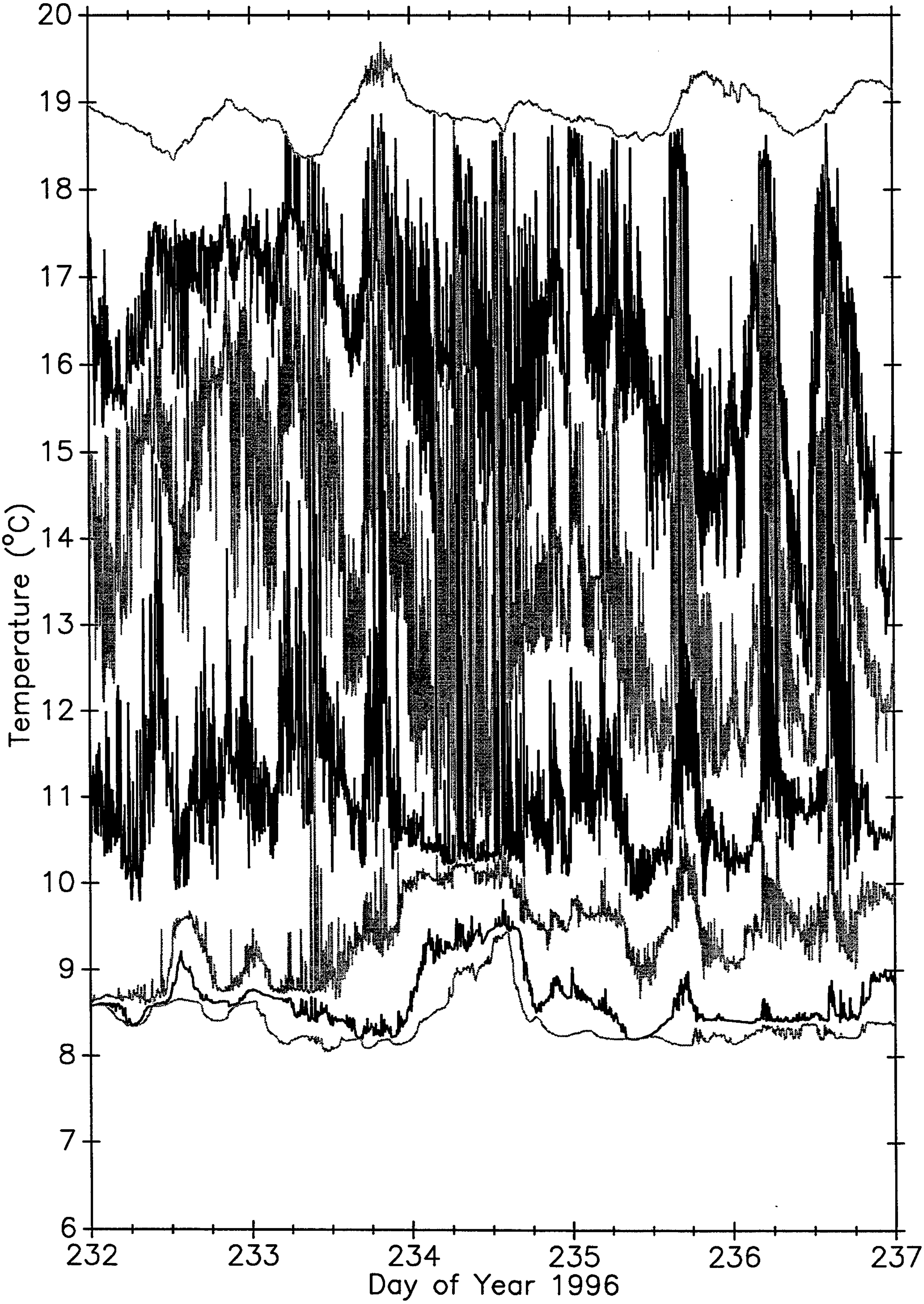

PRIMER Temperatures at 2m (Met) 11.5m 18m 26m 54m 65m (Main)
Temperature (°C)
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
217
218
219
220
221
222
Day of Year 1996


PRIMER Temperatures at 2m (Met) 11.5m 18m 26m 54m 65m (Main)
Temperature (°C)
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
222
223
224
225
226
227
Day of Year 1996

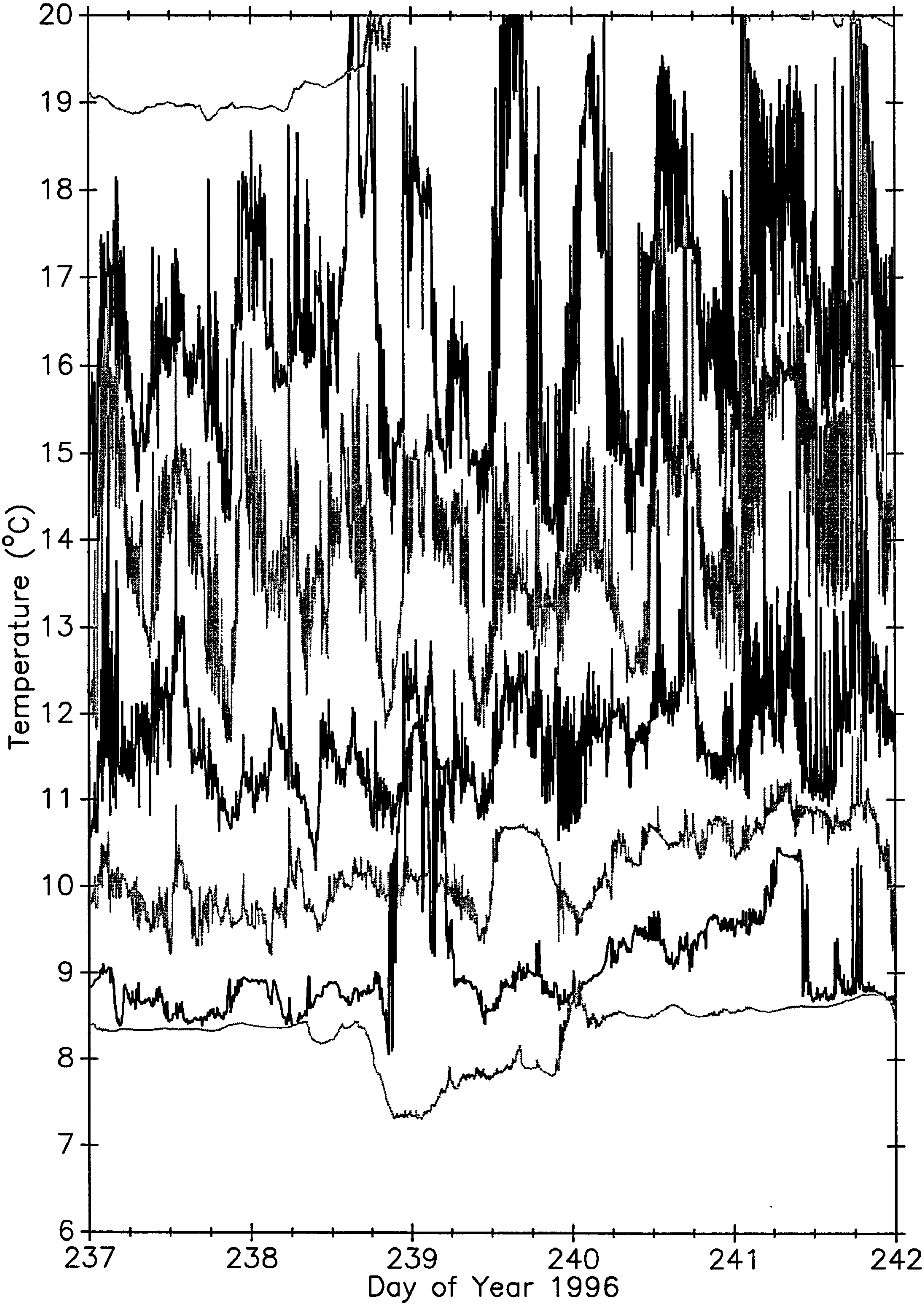
PRIMER Temperatures at 2m (Met) 11.5m 18m 26m 54m 65m (Main)



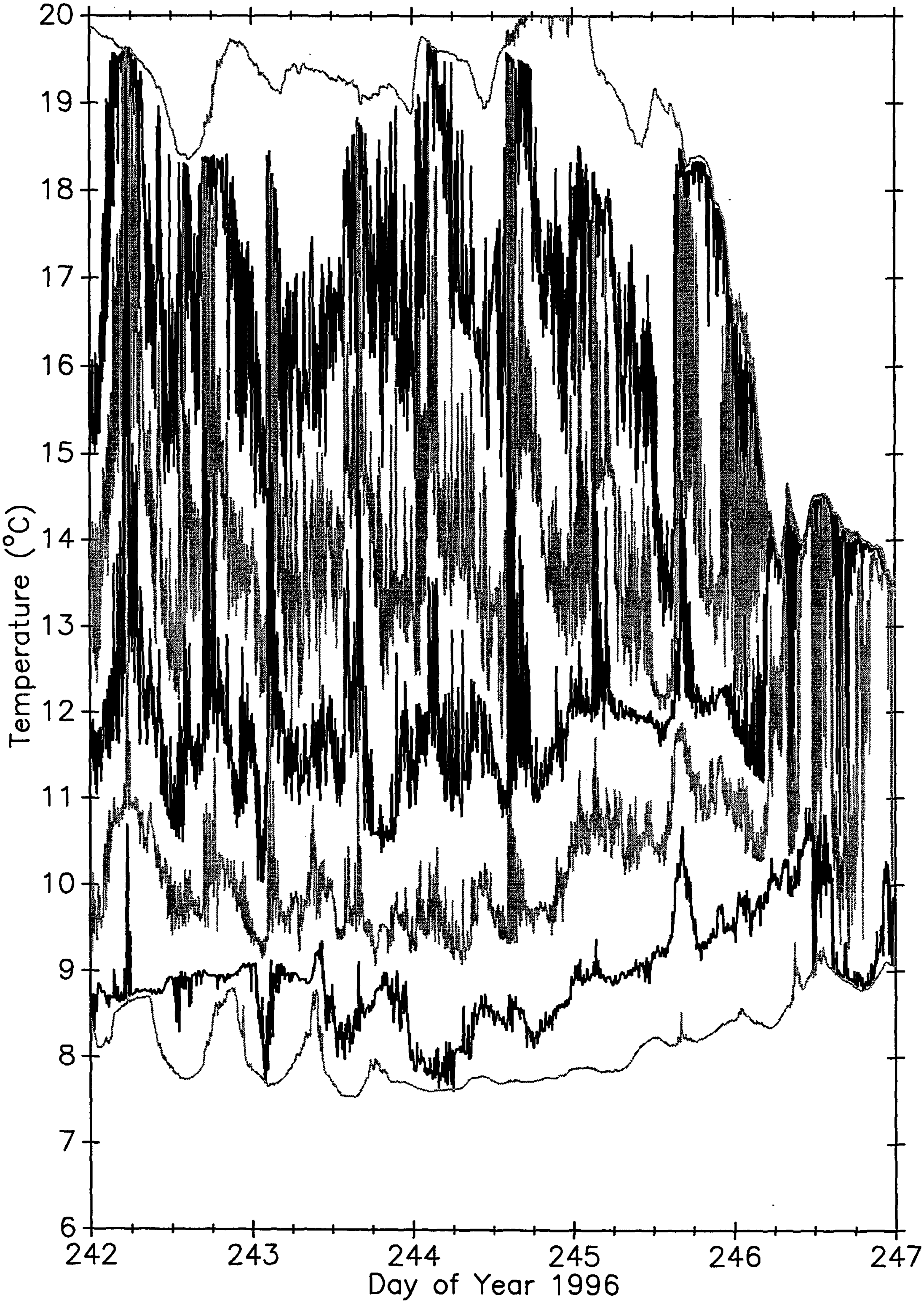
PRIMER Temperatures at 2m (Met) 11.5m 18m 26m 54m 65m (Main)

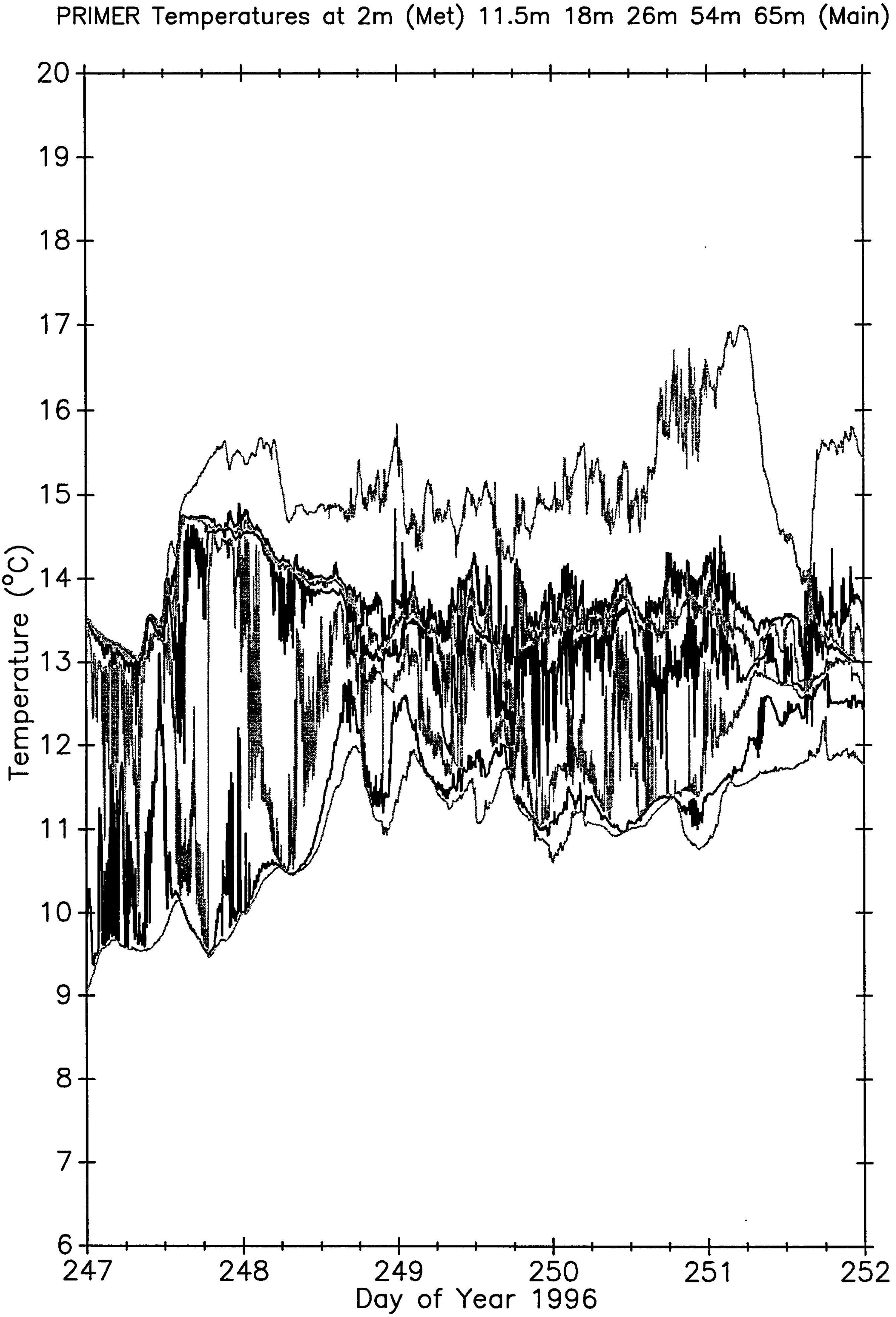


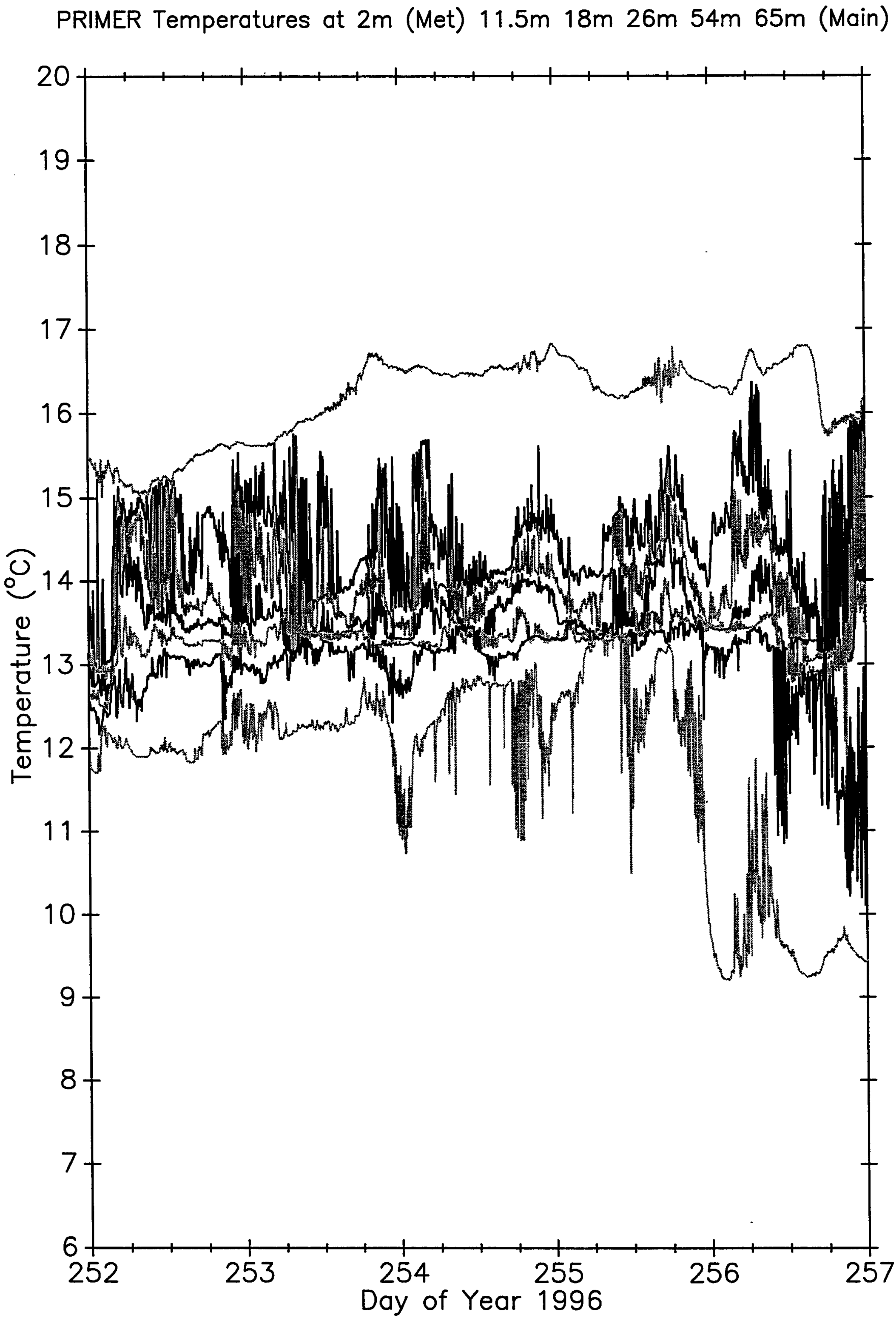
PRIMER Temperatures at 2m (Met) 11.5m 18m 26m 54m 65m (Main)



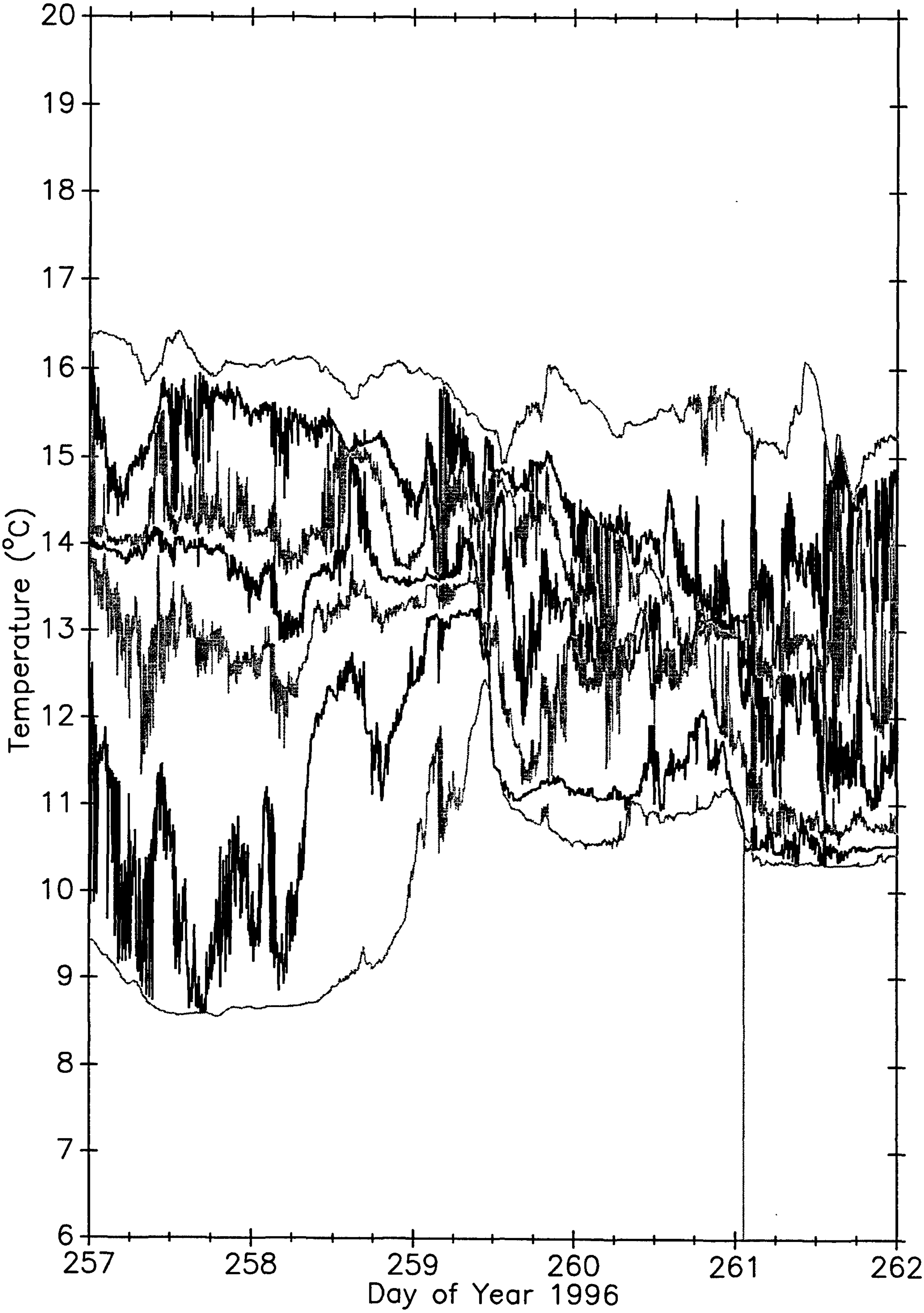
PRIMER Temperatures at 2m (Met) 11.5m 18m 26m 54m 65m (Main)



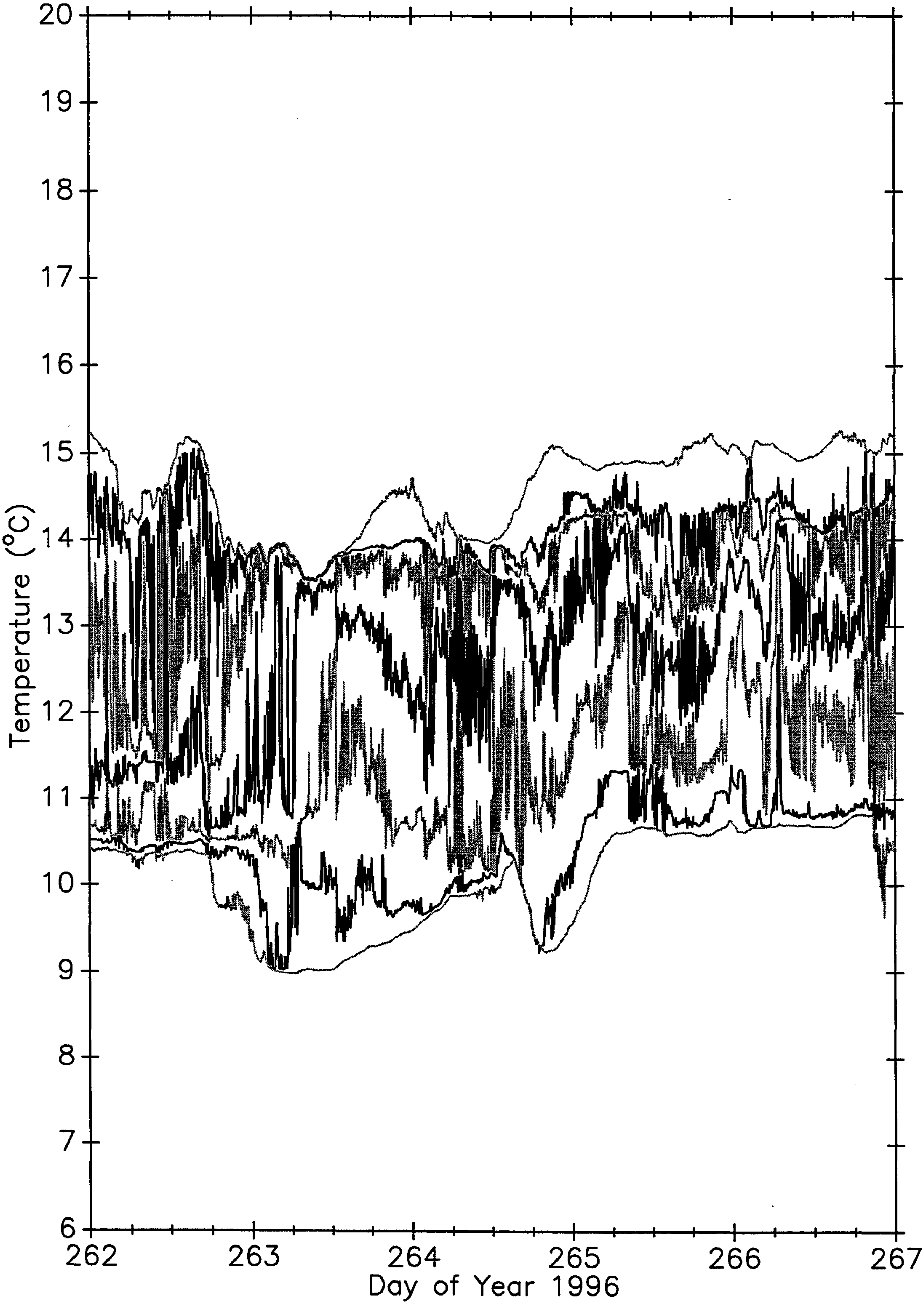

PRIMER Temperatures at 2m (Met) 11.5m 18m 26m 54m 65m (Main)
Temperature (°C)
Day of Year 1996
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
247
248
249
250
251
252

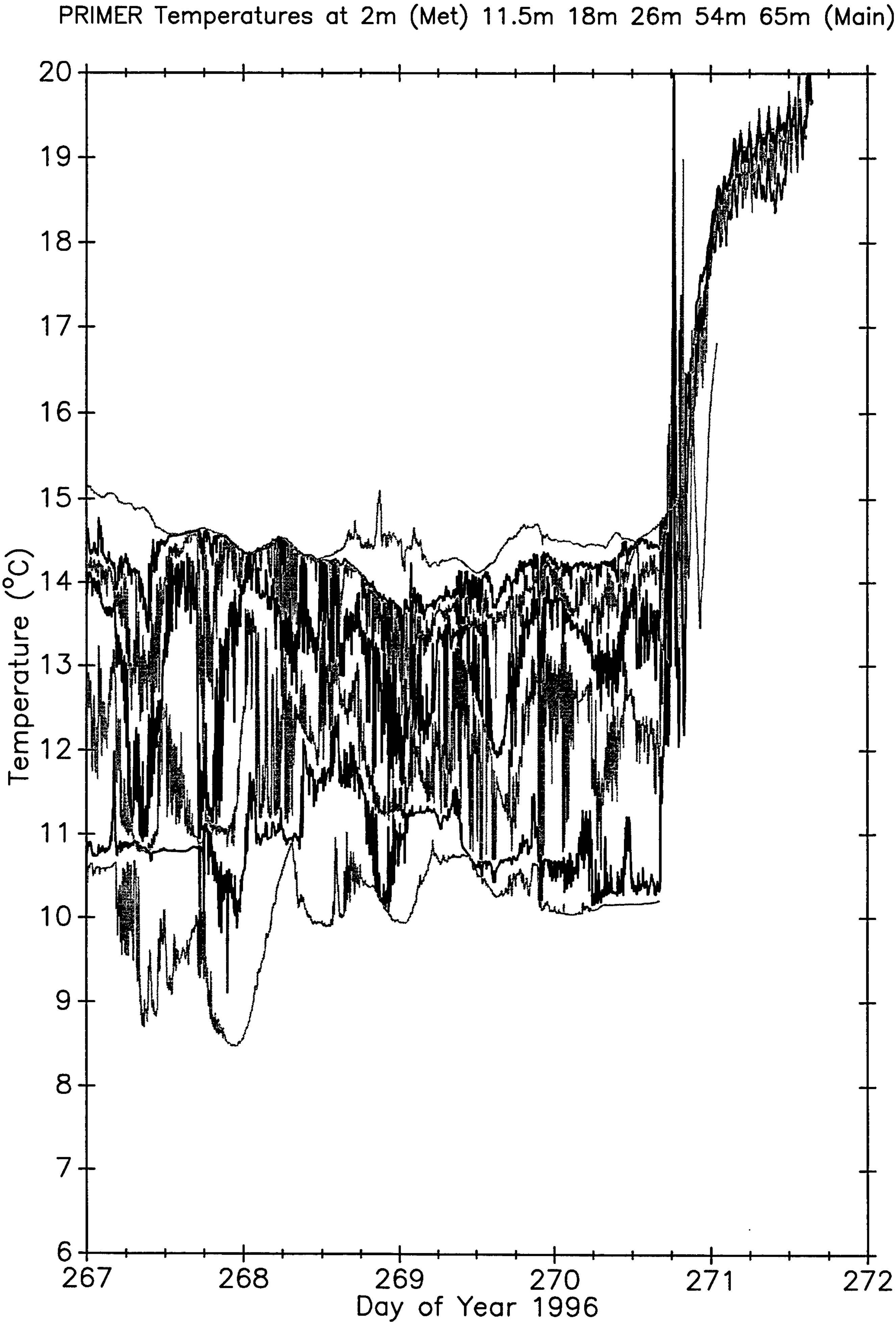

PRIMER Temperatures at 2m (Met) 11.5m 18m 26m 54m 65m (Main)
Temperature (°C)
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
252
253
254
255
256
257
Day of Year 1996

PRIMER Temperatures at 2m (Met) 11.5m 18m 26m 54m 65m (Main)



PRIMER Temperatures at 2m (Met) 11.5m 18m 26m 54m 65m (Main)




PRIMER Temperatures at 2m (Met) 11.5m 18m 26m 54m 65m (Main)
Temperature (°C)
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
267
268
269
270
271
272
Day of Year 1996

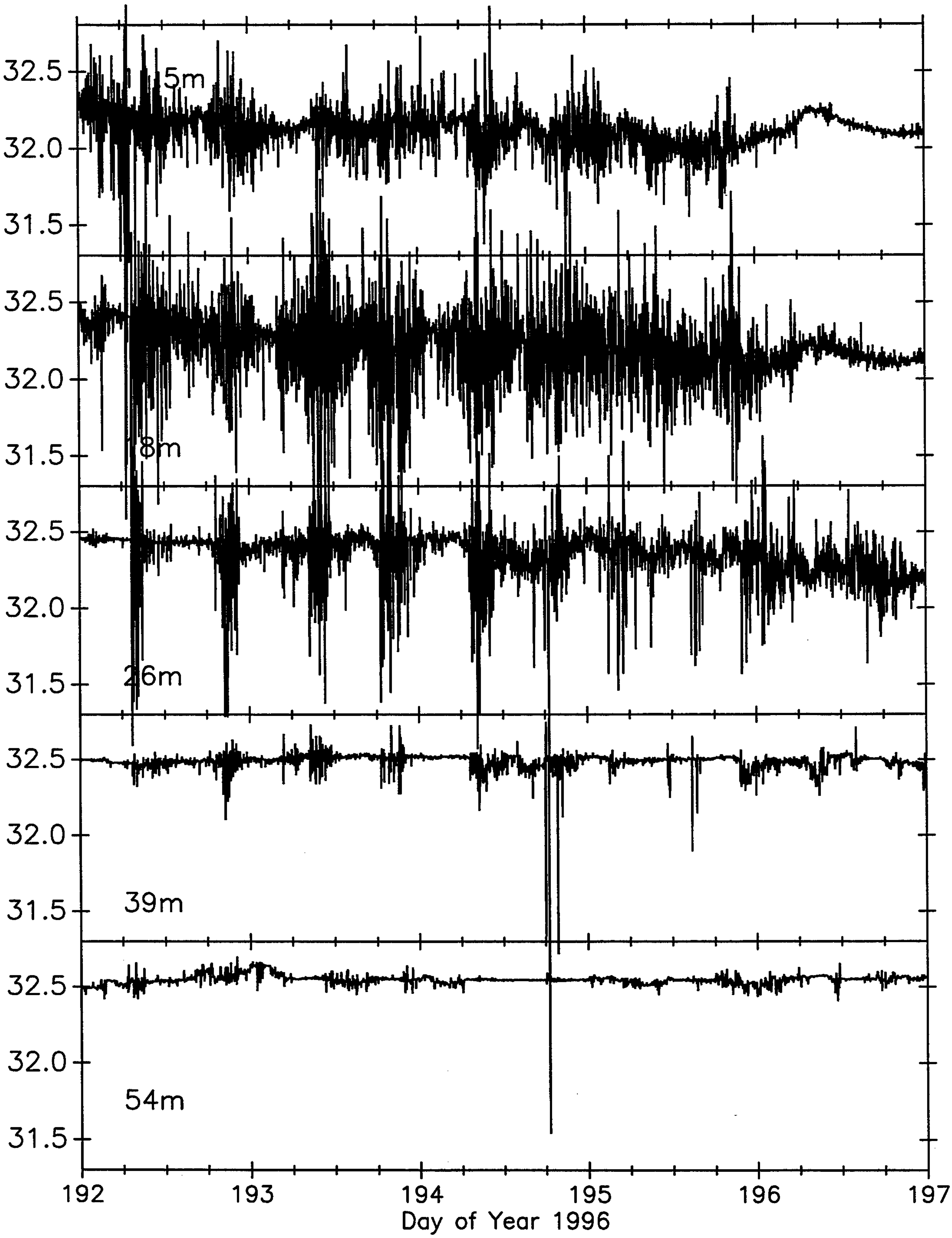
SALINITY Time Series

Main Mooring

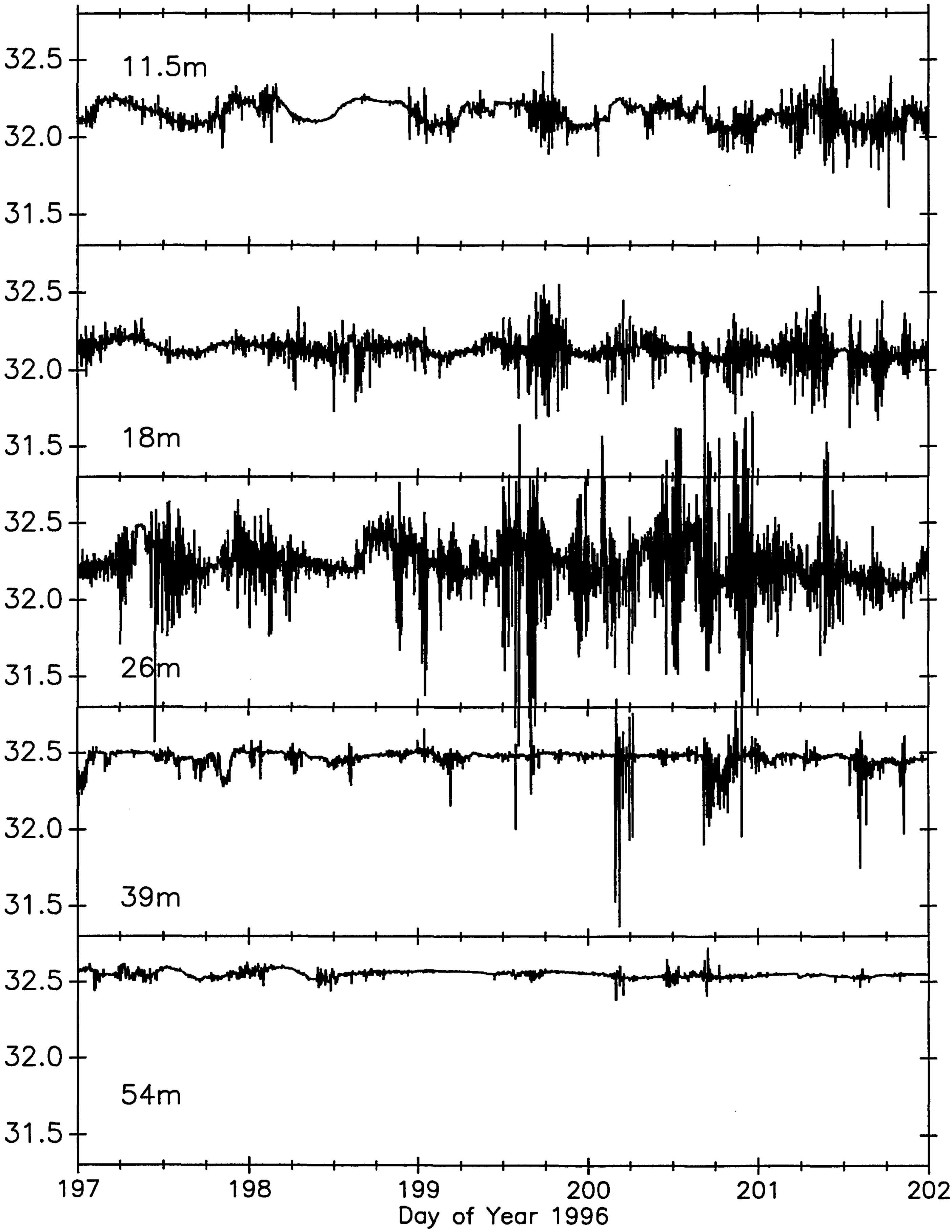
Unfiltered

Salinity from Seacats deployed on the Main mooring at depths 11.5 m, 18 m, 26 m, 39 m, and 54 m. Salinities are not filtered. Sampling rates are shown in Tables 1-3. Note that the calibration of the Seacat at 18 m shifted relative to the Seacats at 11 m and 26 m on day 238. Absolute salinity at 18 m is not reliable after day 238.

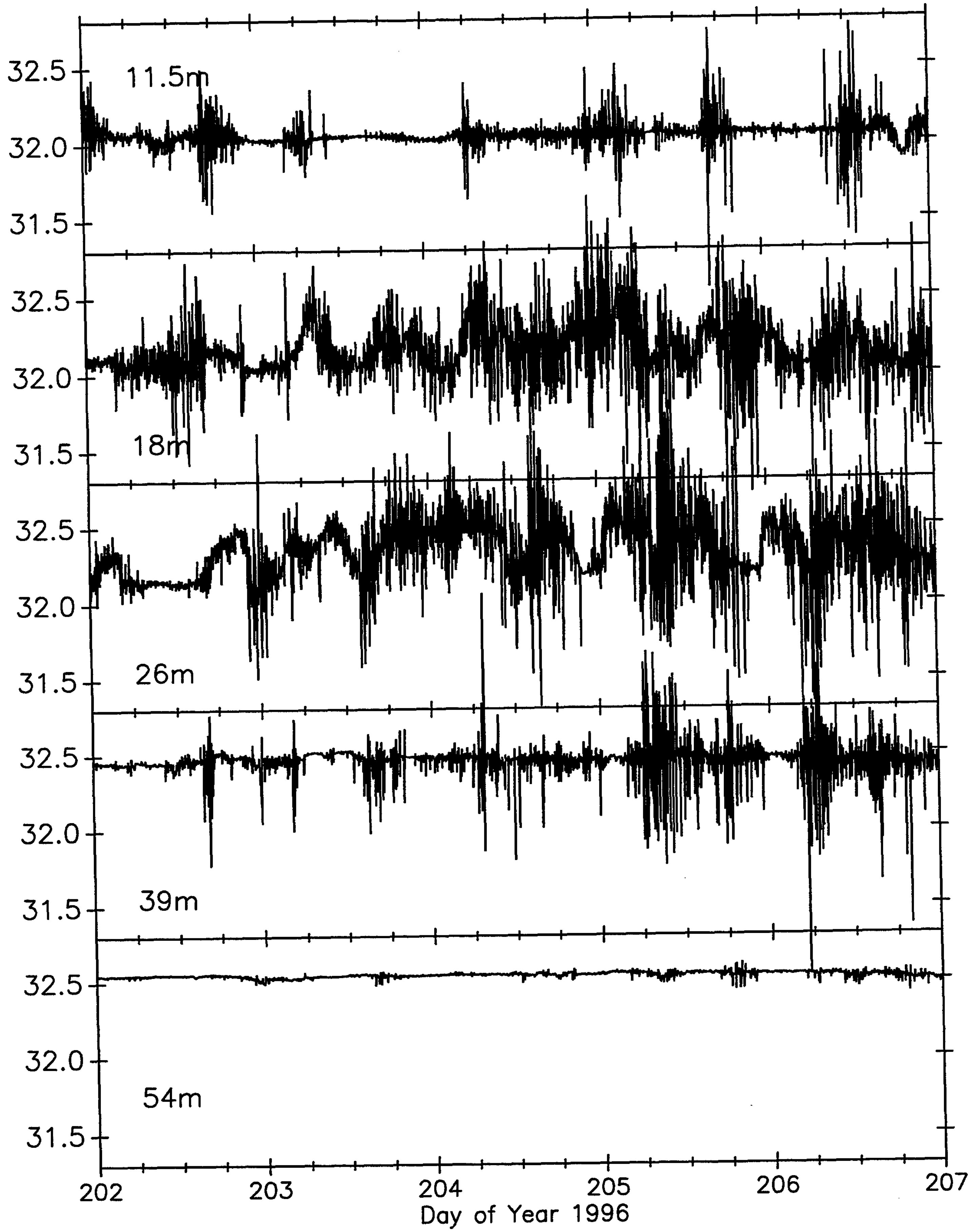
PRIMER SEACAT SALINITY

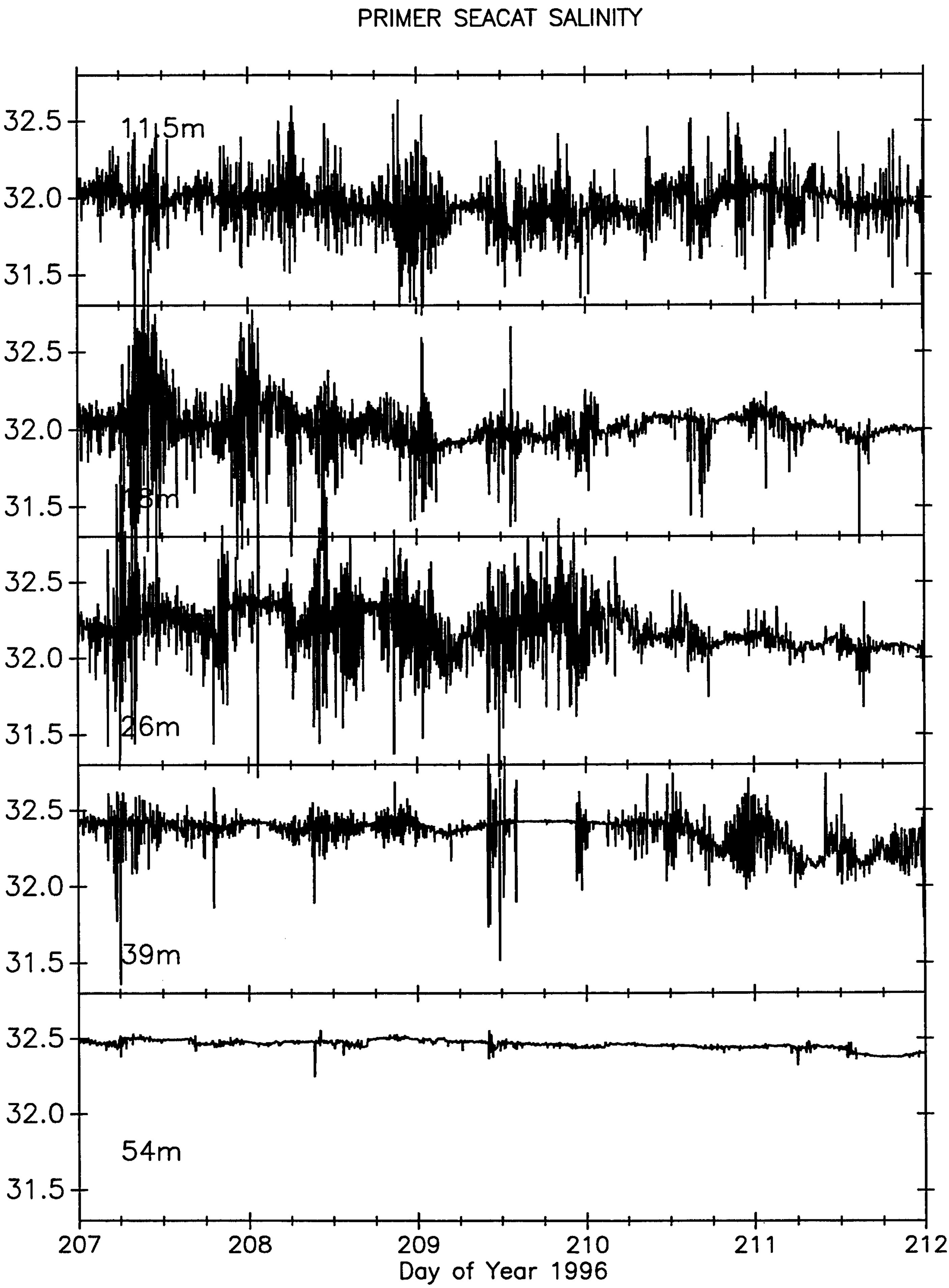


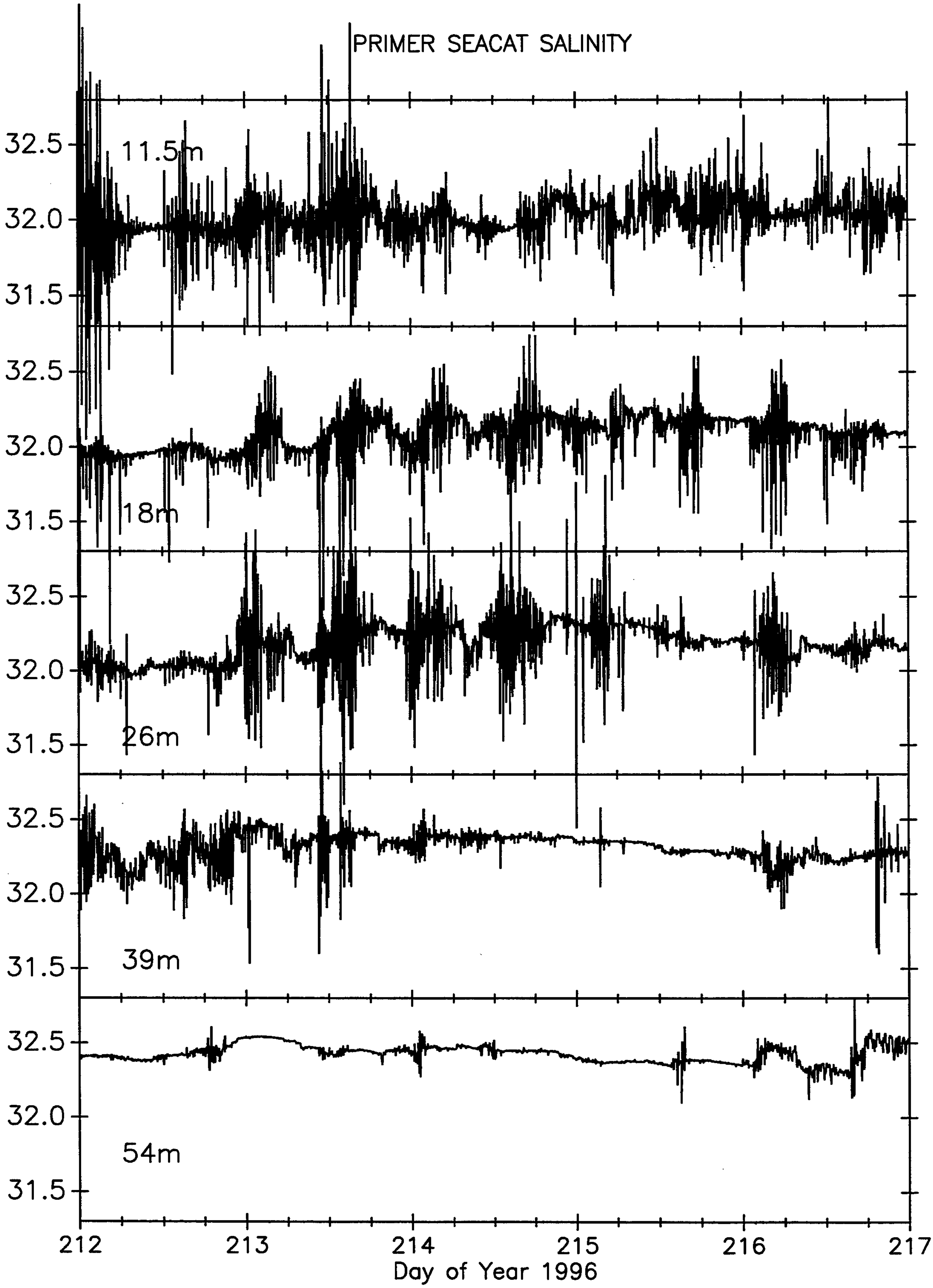
PRIMER SEACAT SALINITY

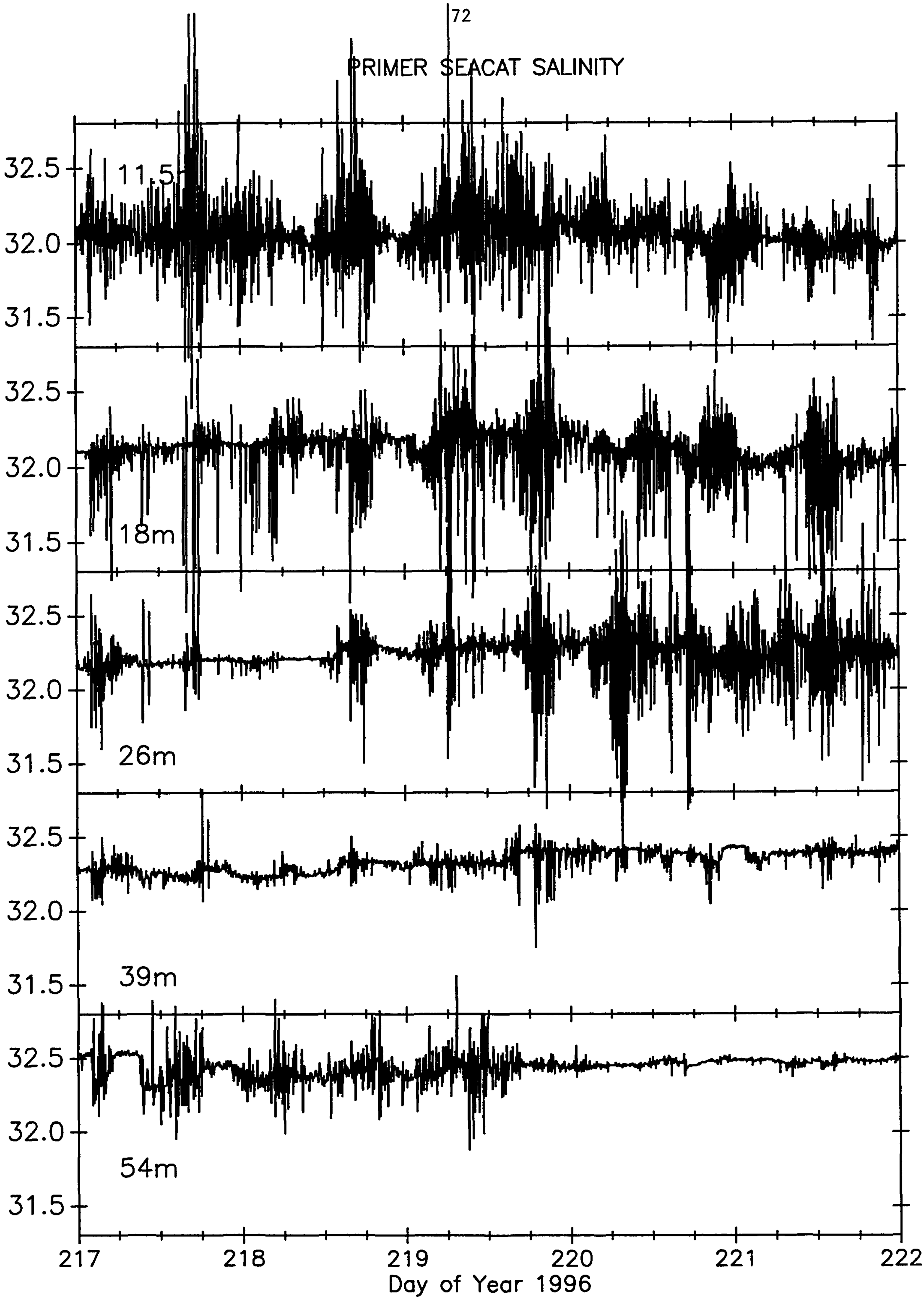


PRIMER SEACAT SALINITY

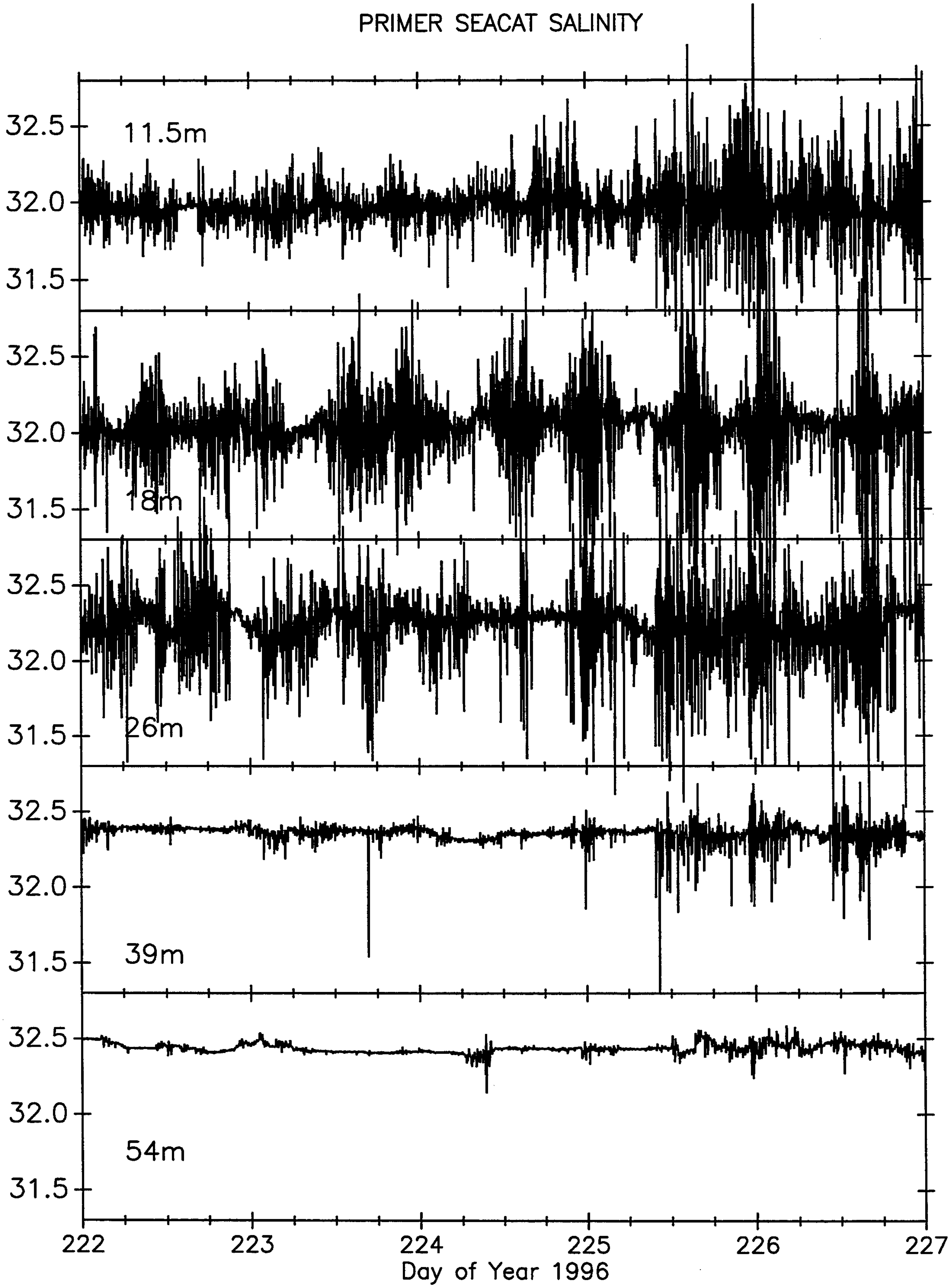


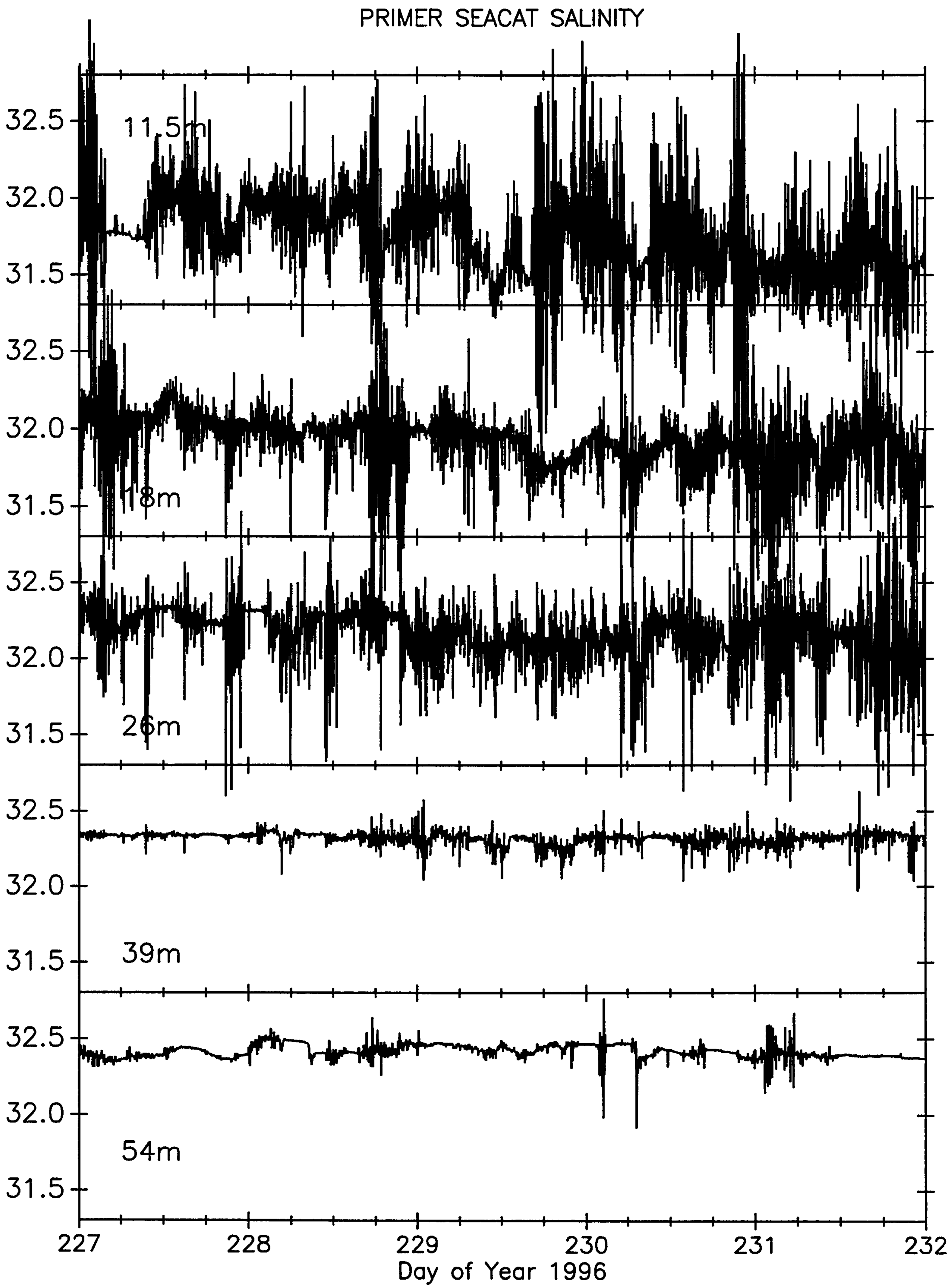

PRIMER SEACAT SALINITY
11.5m
18m
26m
39m
54m
32.5
32.0
31.5
207
208
209
210
211
212
Day of Year 1996

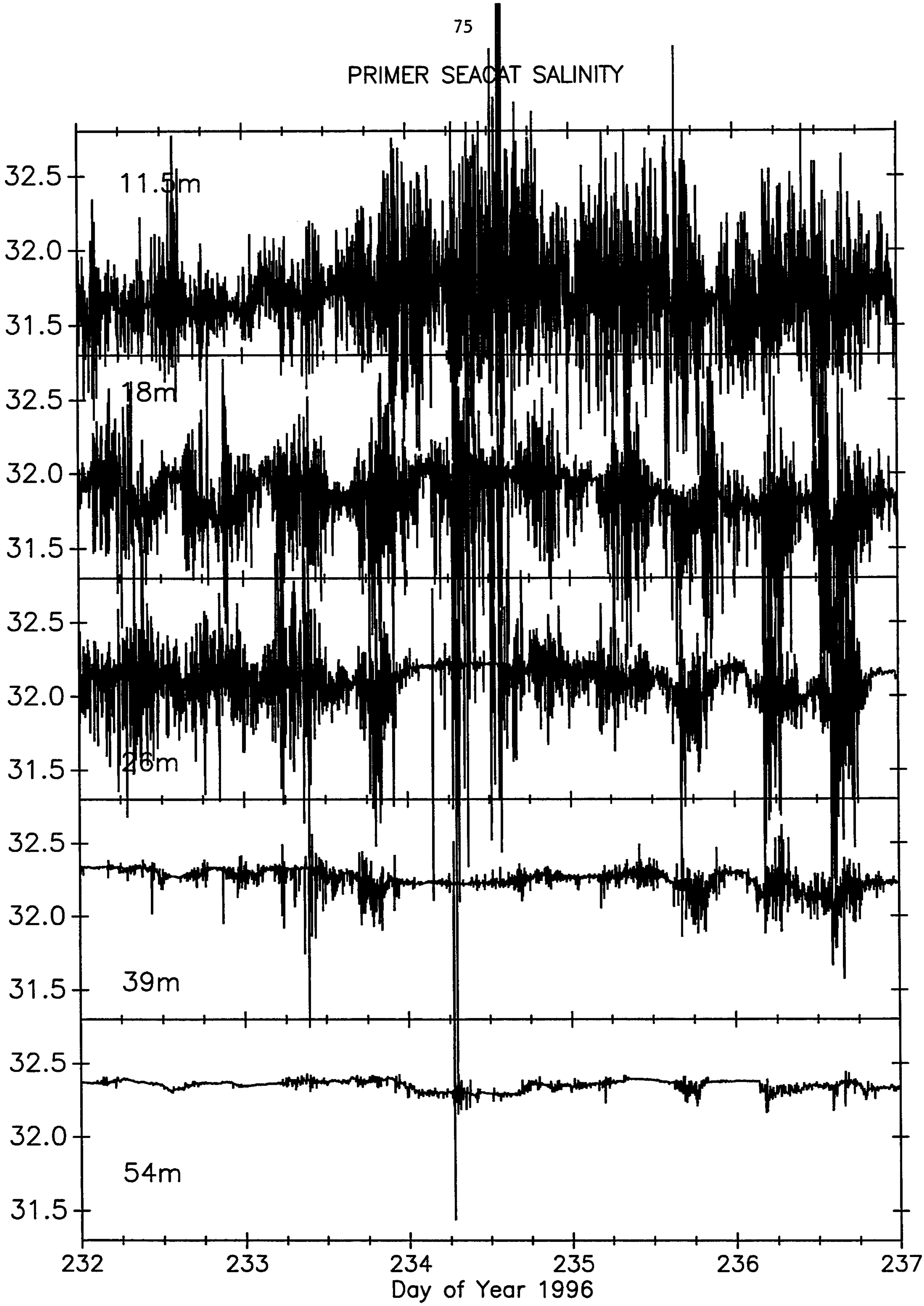

PRIMER SEACAT SALINITY
11.5m
18m
26m
39m
54m
32.5
32.0
31.5
212
213
214
215
216
217
Day of Year 1996

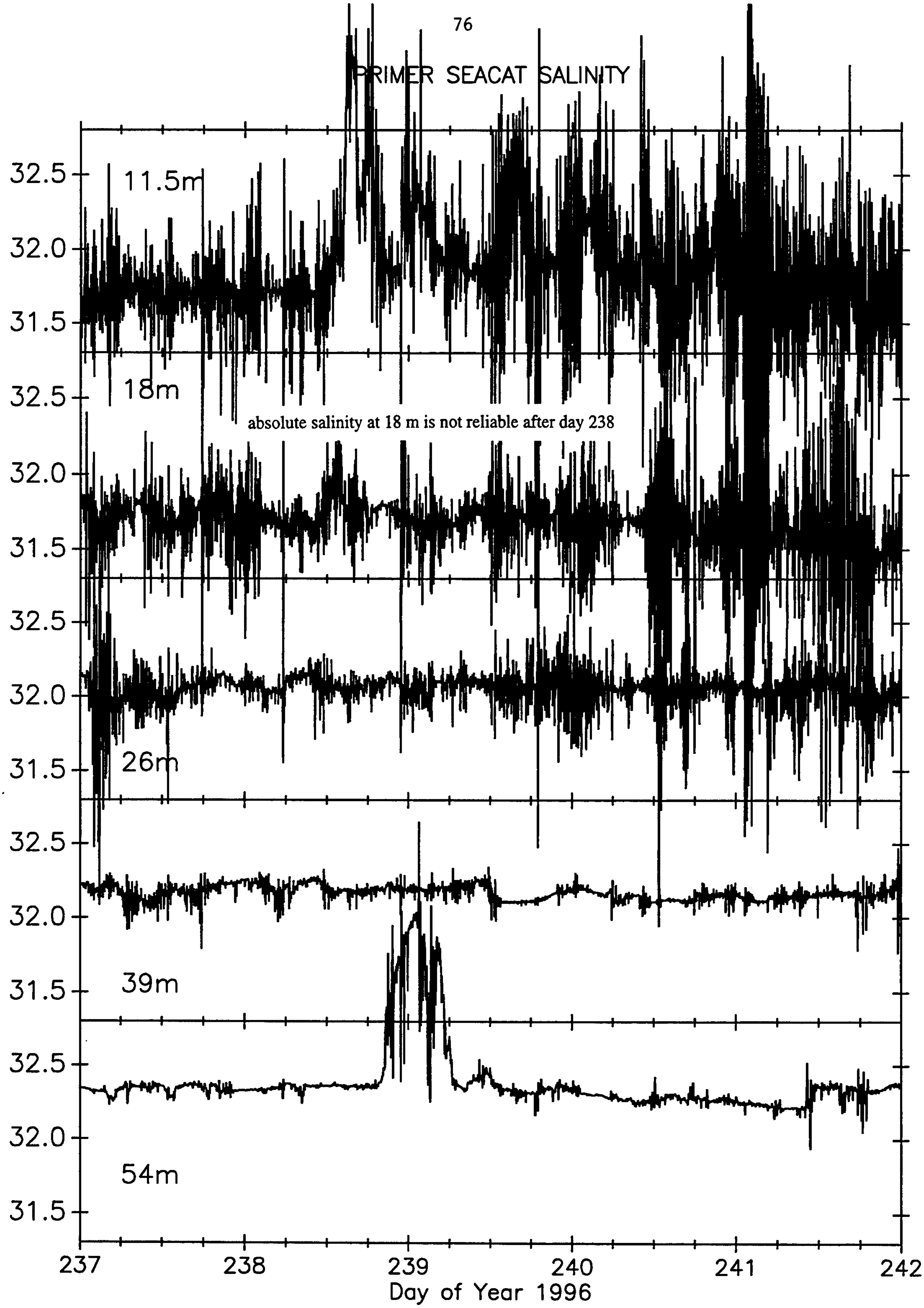

PRIMER SEACAT SALINITY
32.5
32.0
31.5
11.5
18m
26m
39m
54m
217
218
219
220
221
222
Day of Year 1996

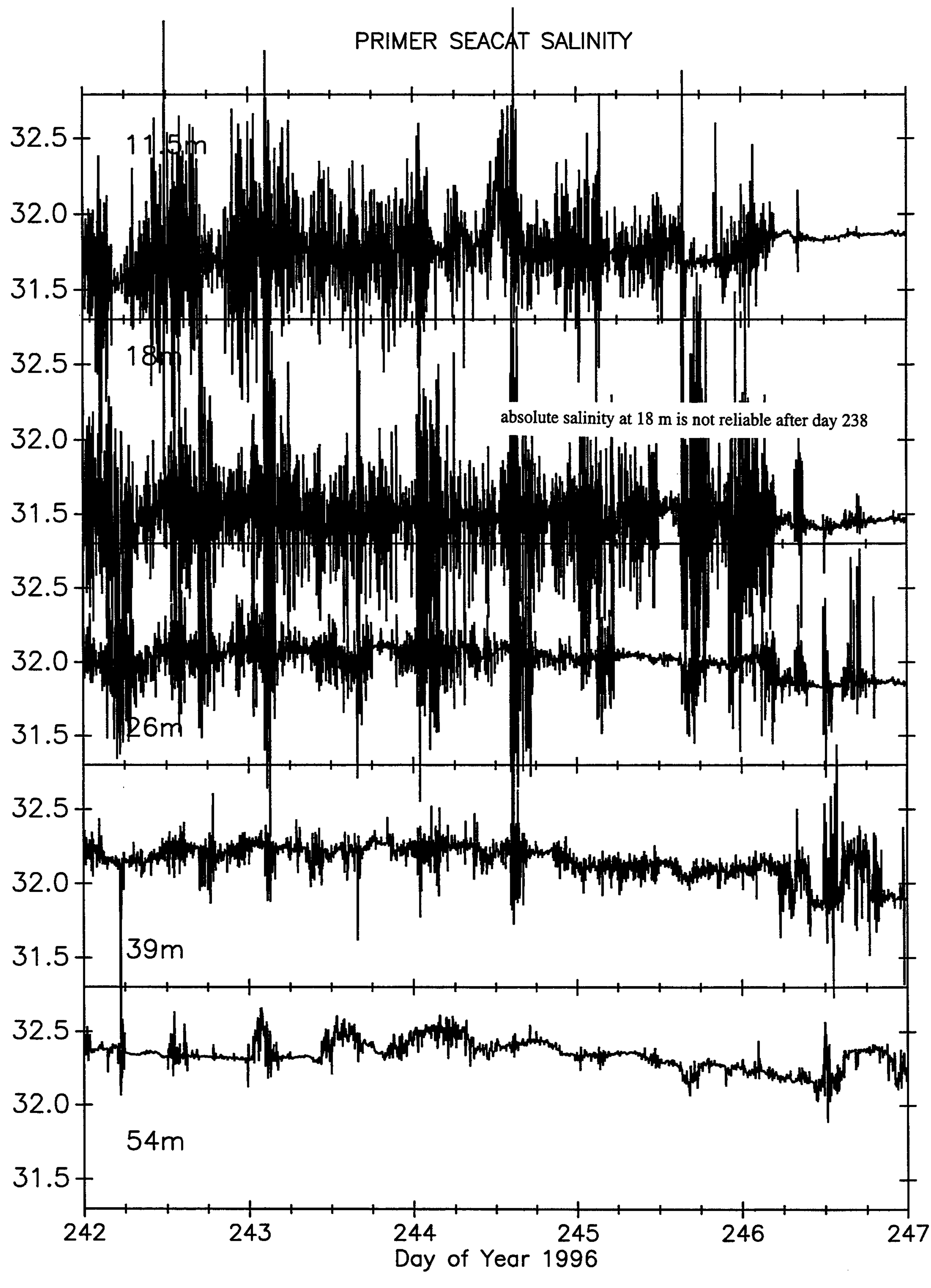
PRIMER SEACAT SALINITY



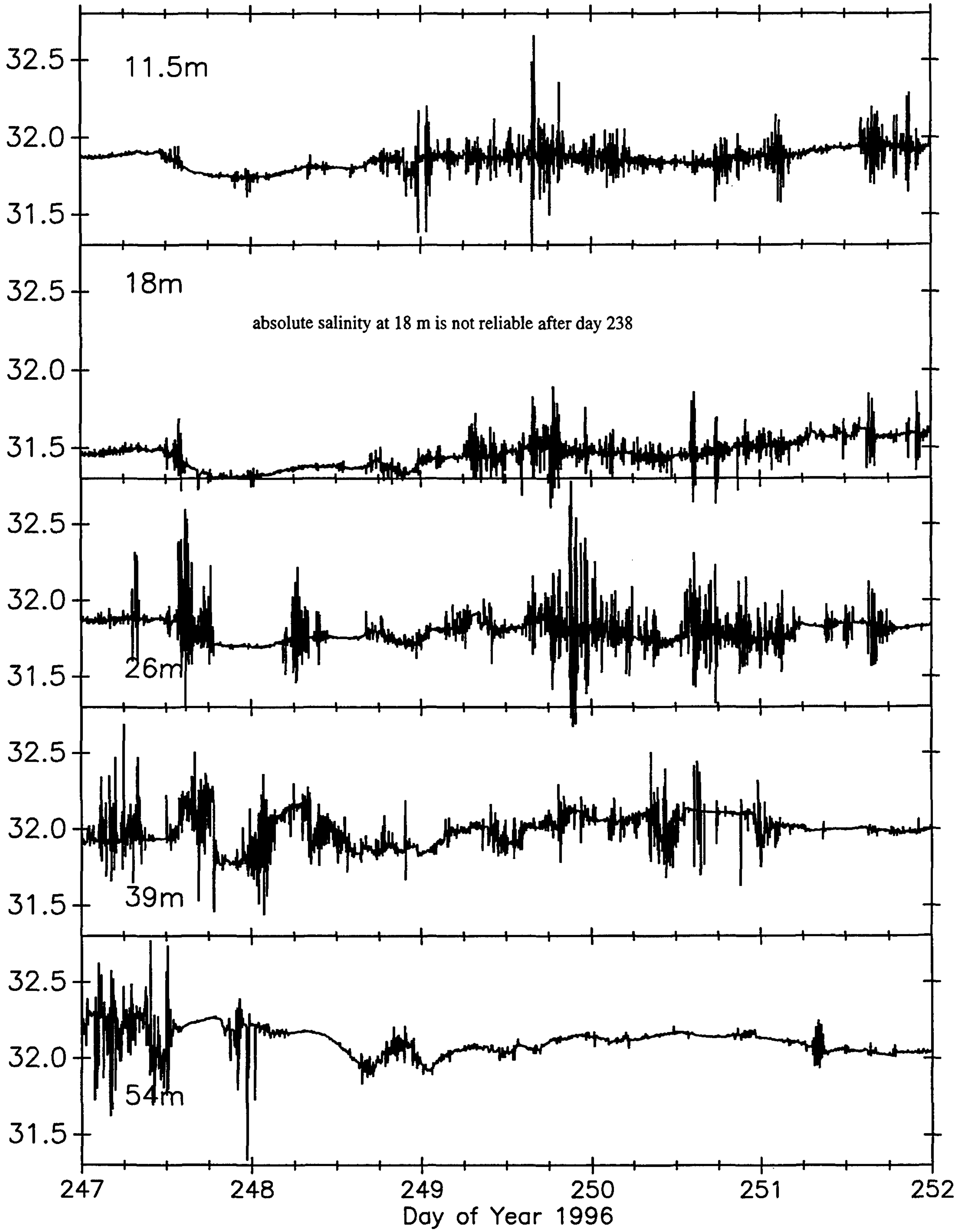

PRIMER SEACAT SALINITY
11.5m
18m
26m
39m
54m
32.5
32.0
31.5
227
228
229
230
231
232
Day of Year 1996

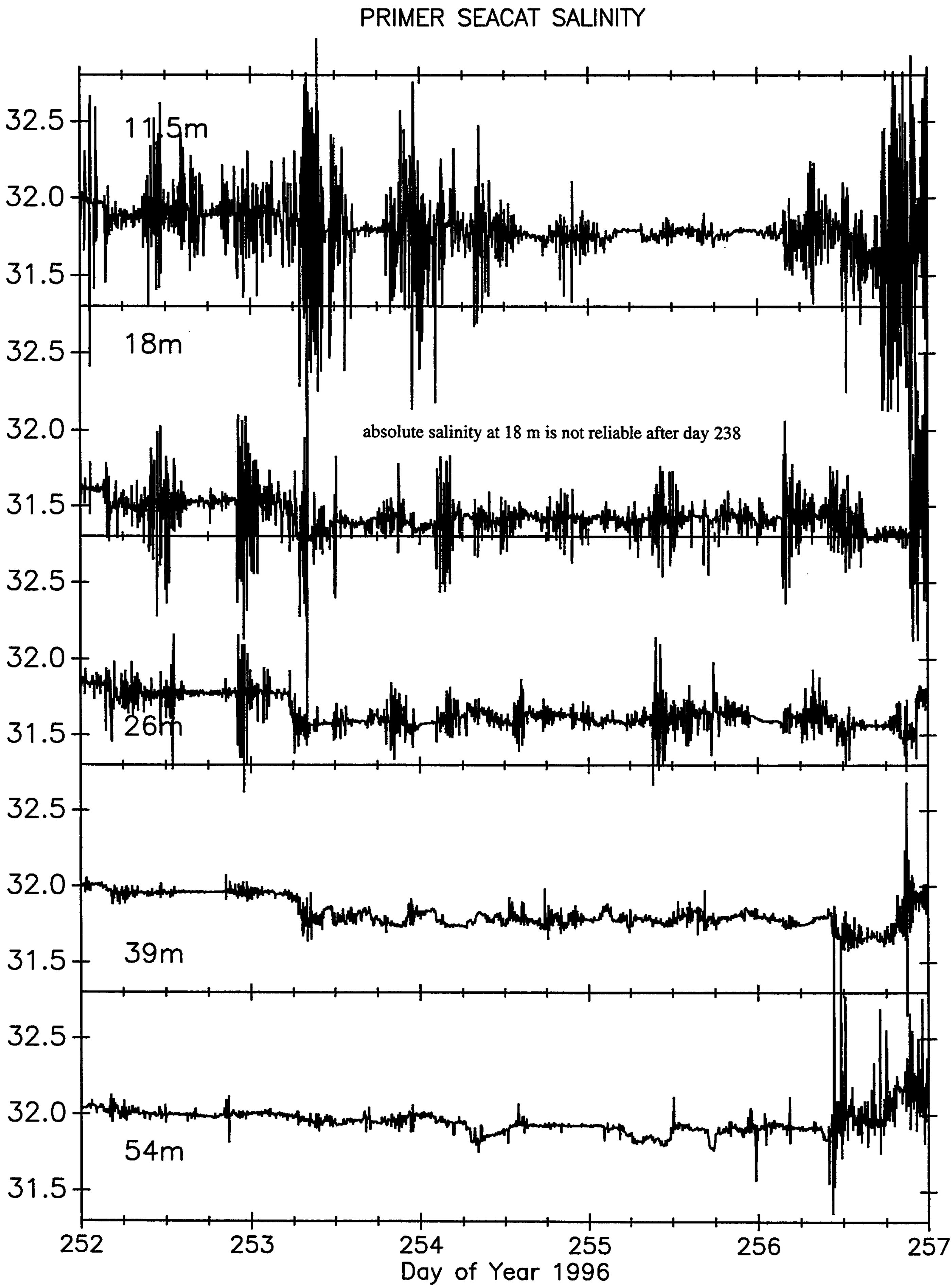

PRIMER SEACAT SALINITY
11.5m
18m
26m
39m
54m
32.5
32.0
31.5
232
233
234
235
236
237
Day of Year 1996

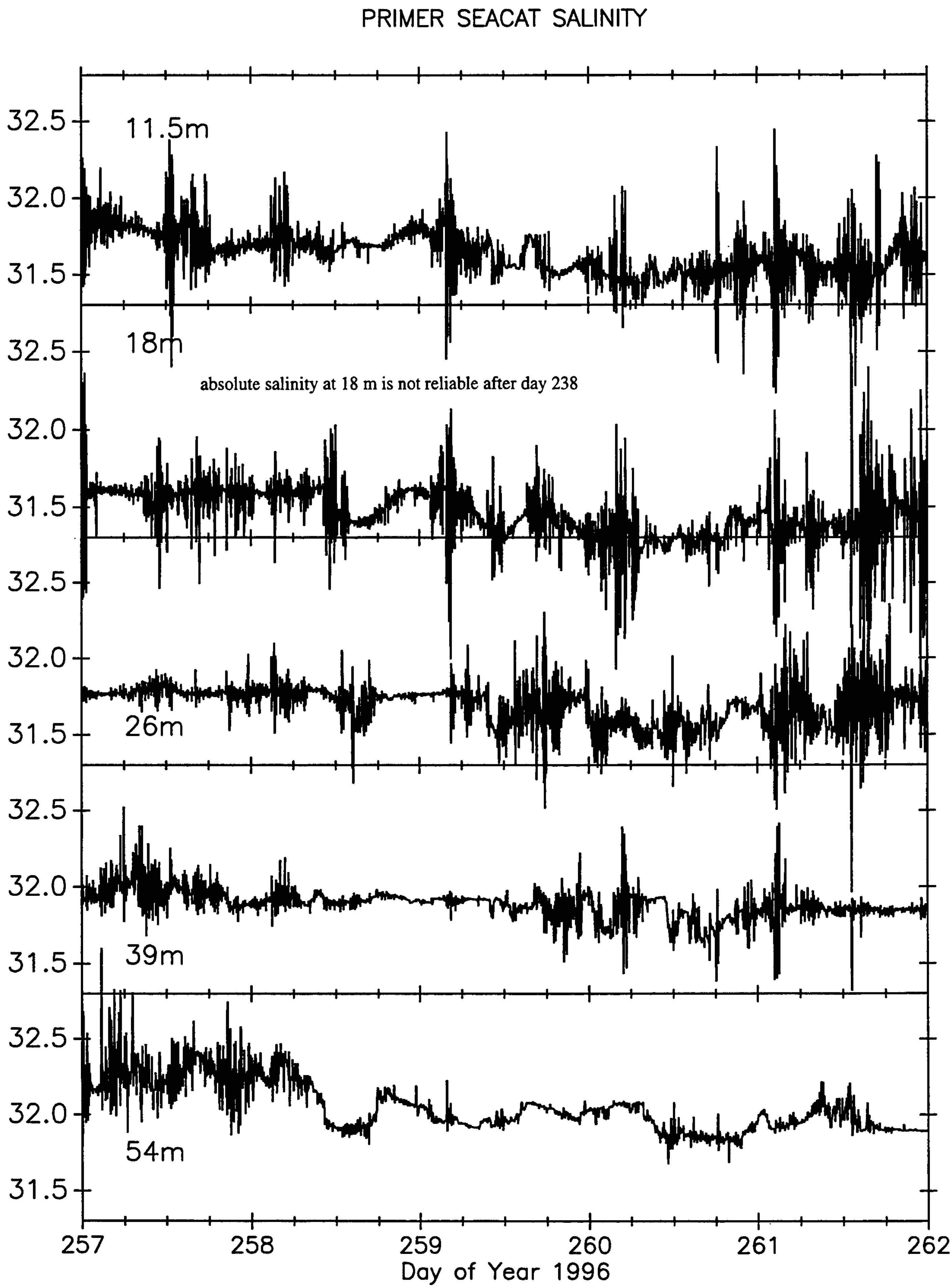

PRIMER SEACAT SALINITY
11.5m
18m
absolute salinity at 18 m is not reliable after day 238
26m
39m
54m
32.5
32.0
31.5
237
238
239
240
241
242
Day of Year 1996


PRIMER SEACAT SALINITY
11.5m
18m
absolute salinity at 18 m is not reliable after day 238
26m
39m
54m
32.5
32.0
31.5
242
243
244
245
246
247
Day of Year 1996

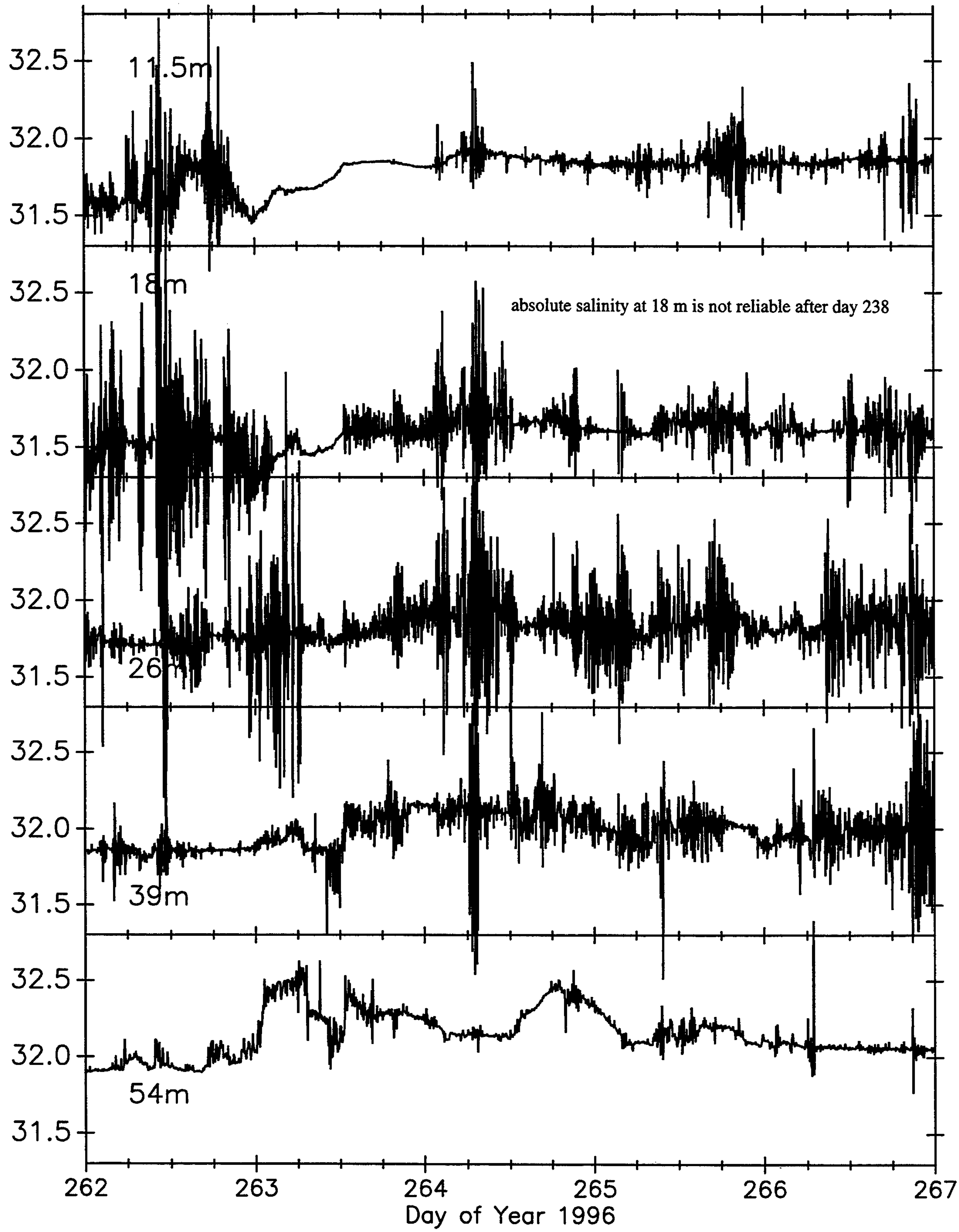
PRIMER SEACAT SALINITY



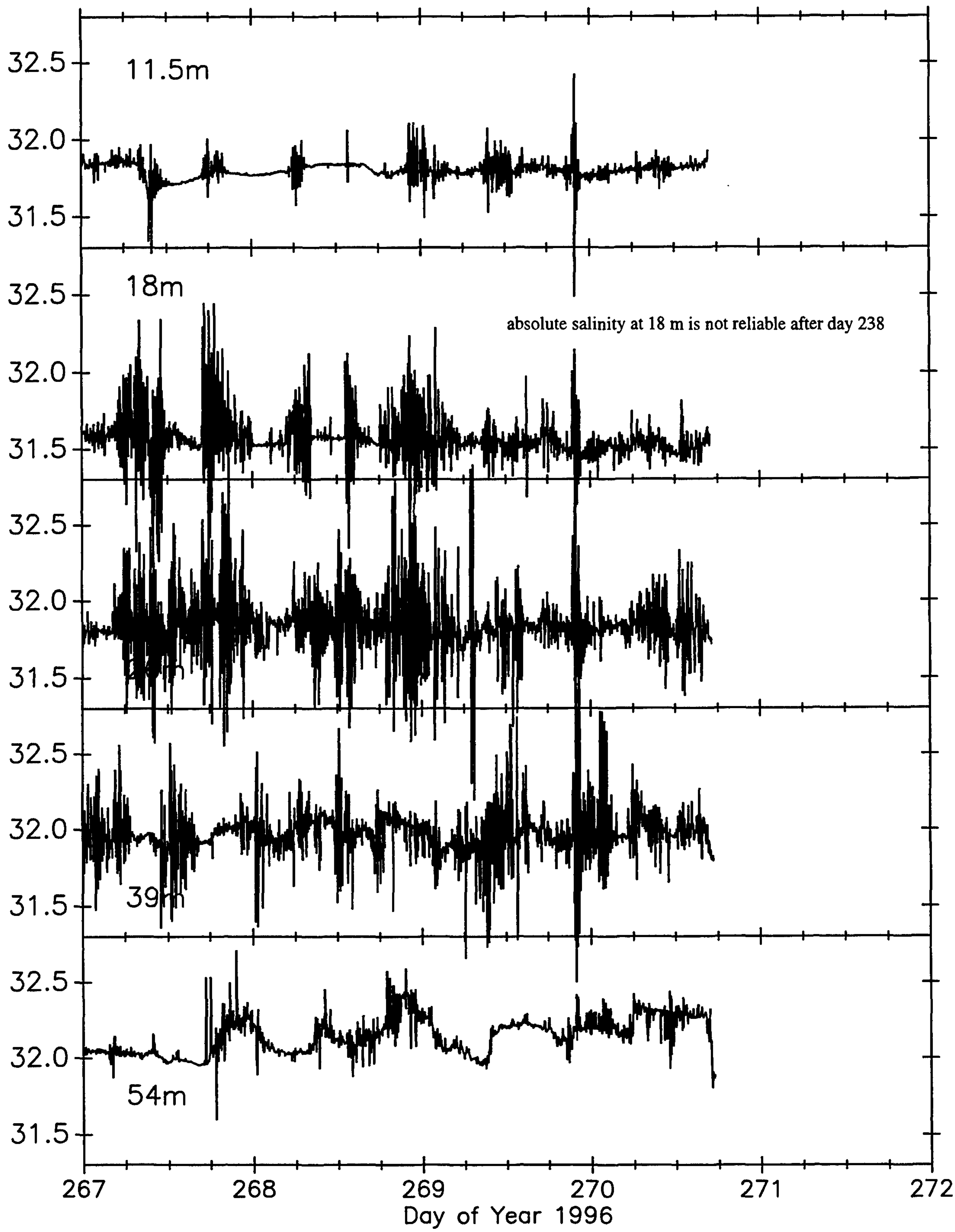

PRIMER SEACAT SALINITY
11.5m
18m
absolute salinity at 18 m is not reliable after day 238
26m
39m
54m
32.5
32.0
31.5
252
253
254
255
256
257
Day of Year 1996


PRIMER SEACAT SALINITY
11.5m
18m
absolute salinity at 18 m is not reliable after day 238
26m
39m
54m
32.5
32.0
31.5
257
258
259
260
261
262
Day of Year 1996

PRIMER SEACAT SALINITY



PRIMER SEACAT SALINITY



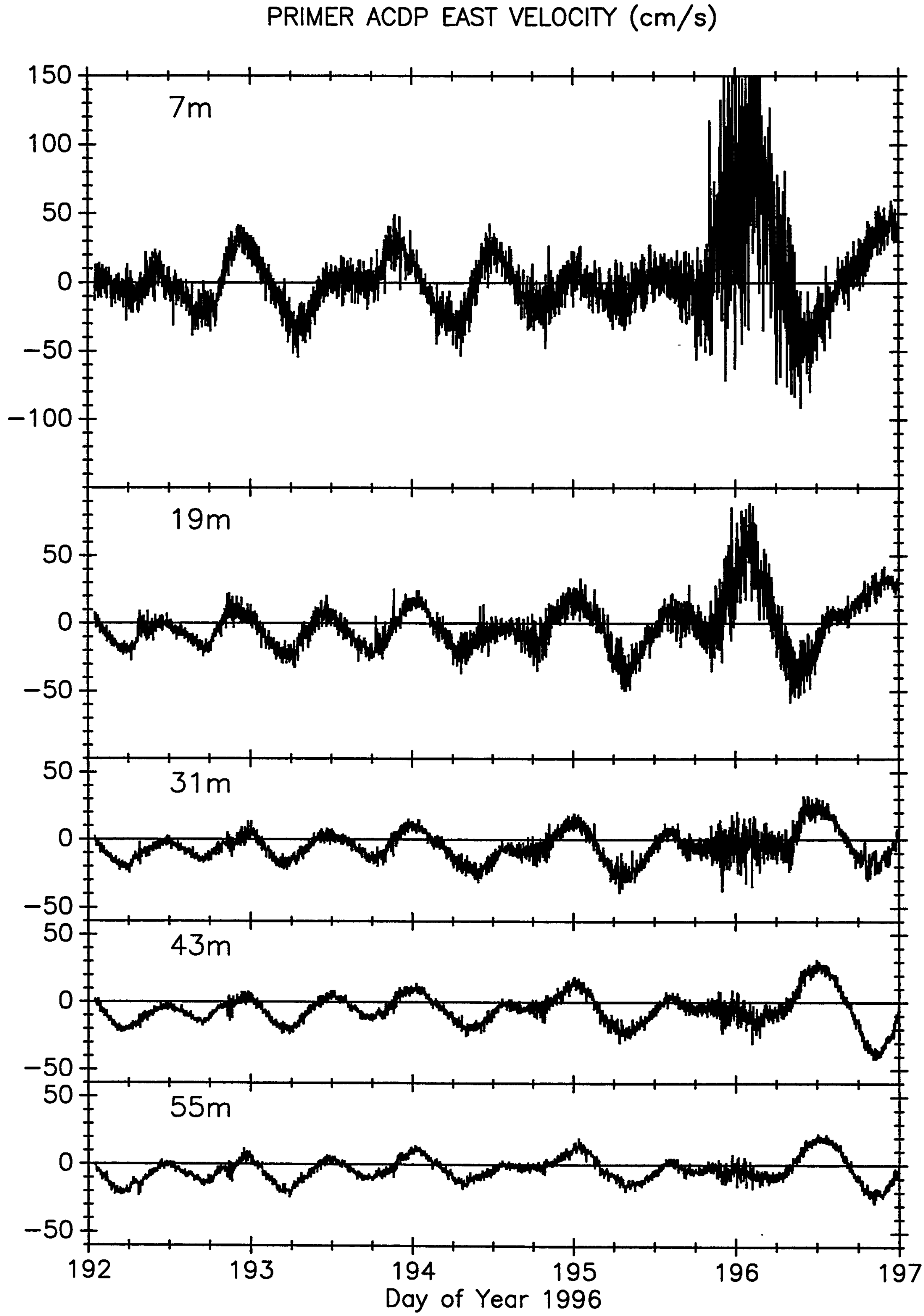
VELOCITY (ADCP) Time Series

East Component

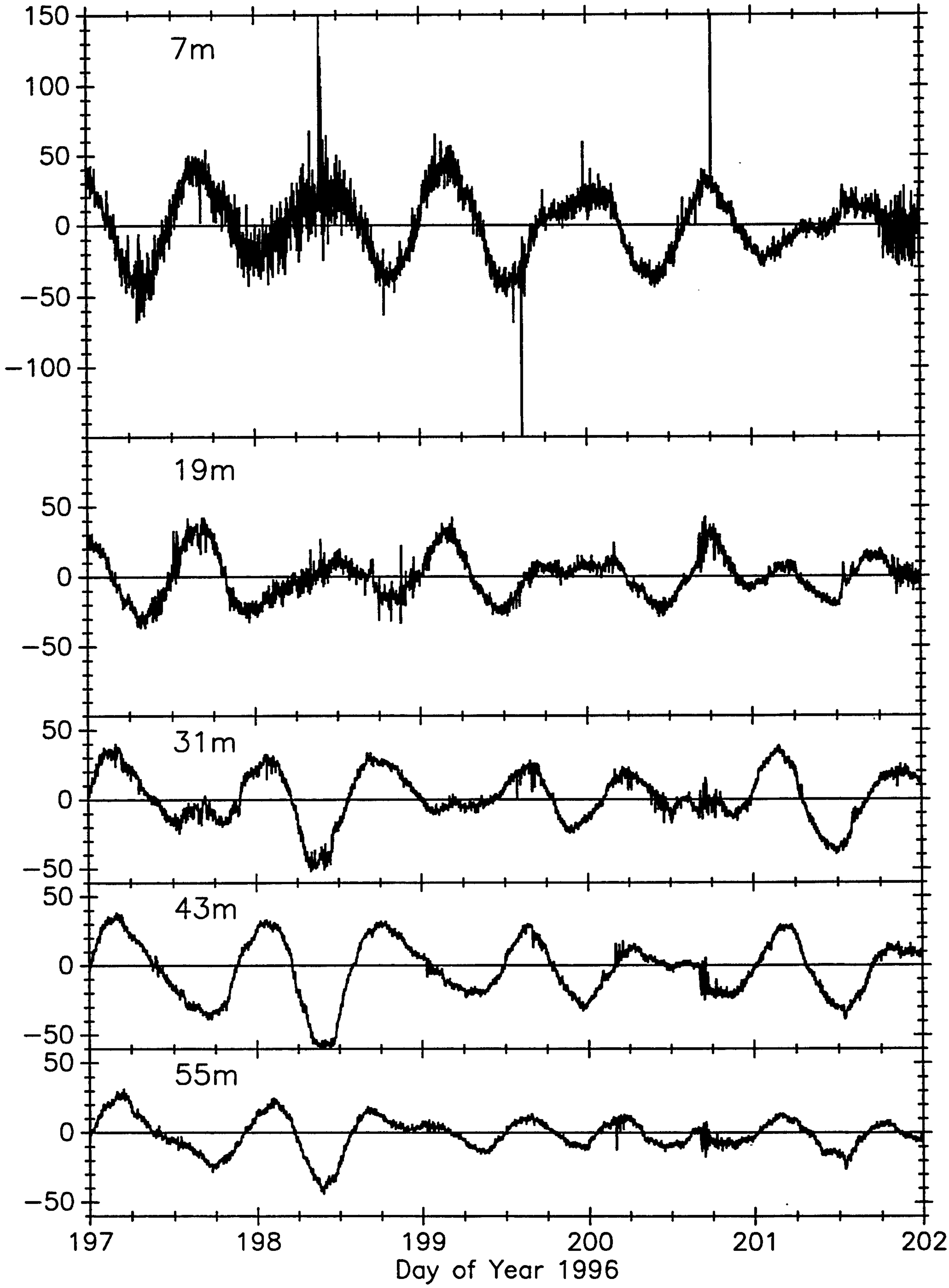
Main Mooring

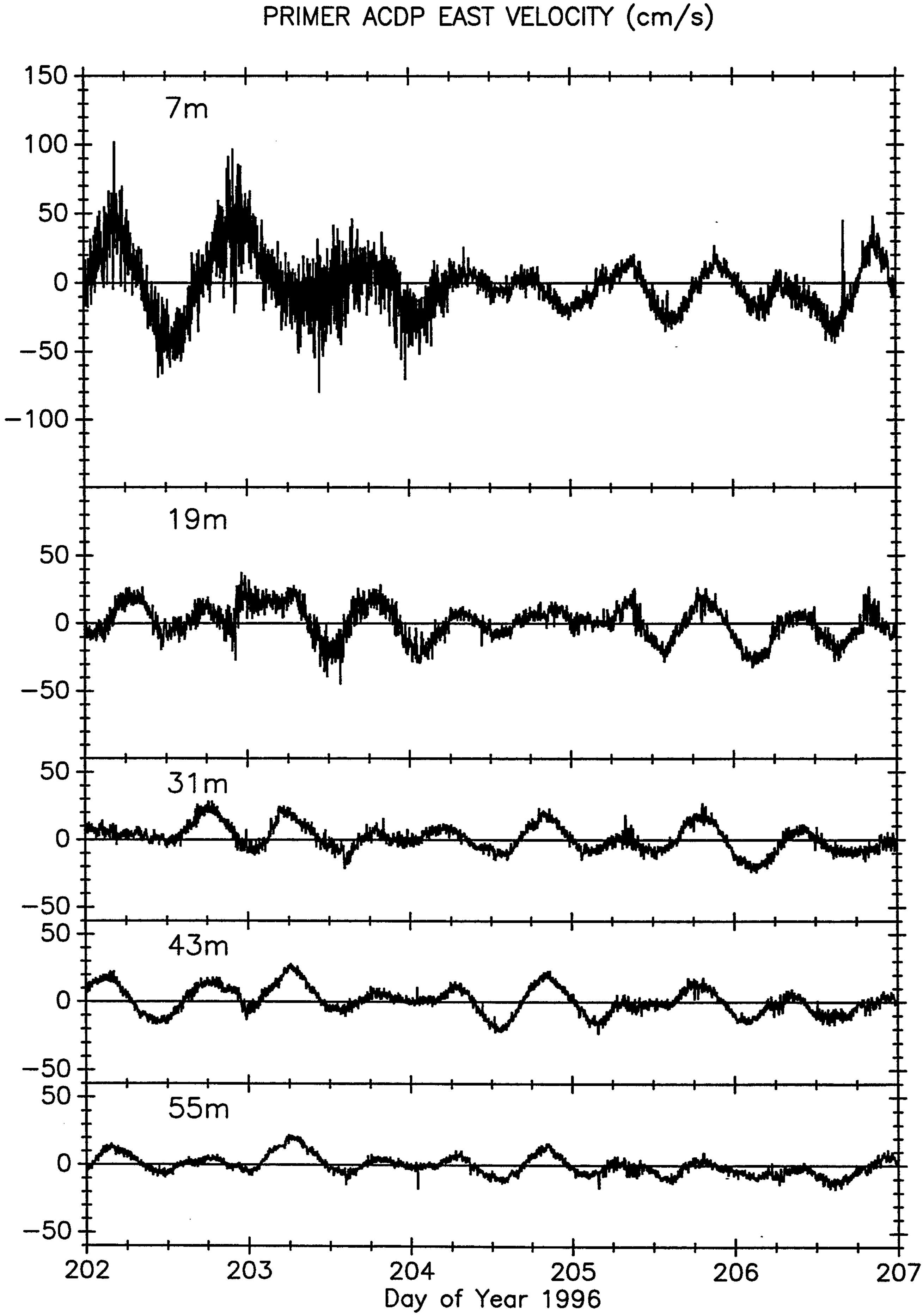
Unfiltered

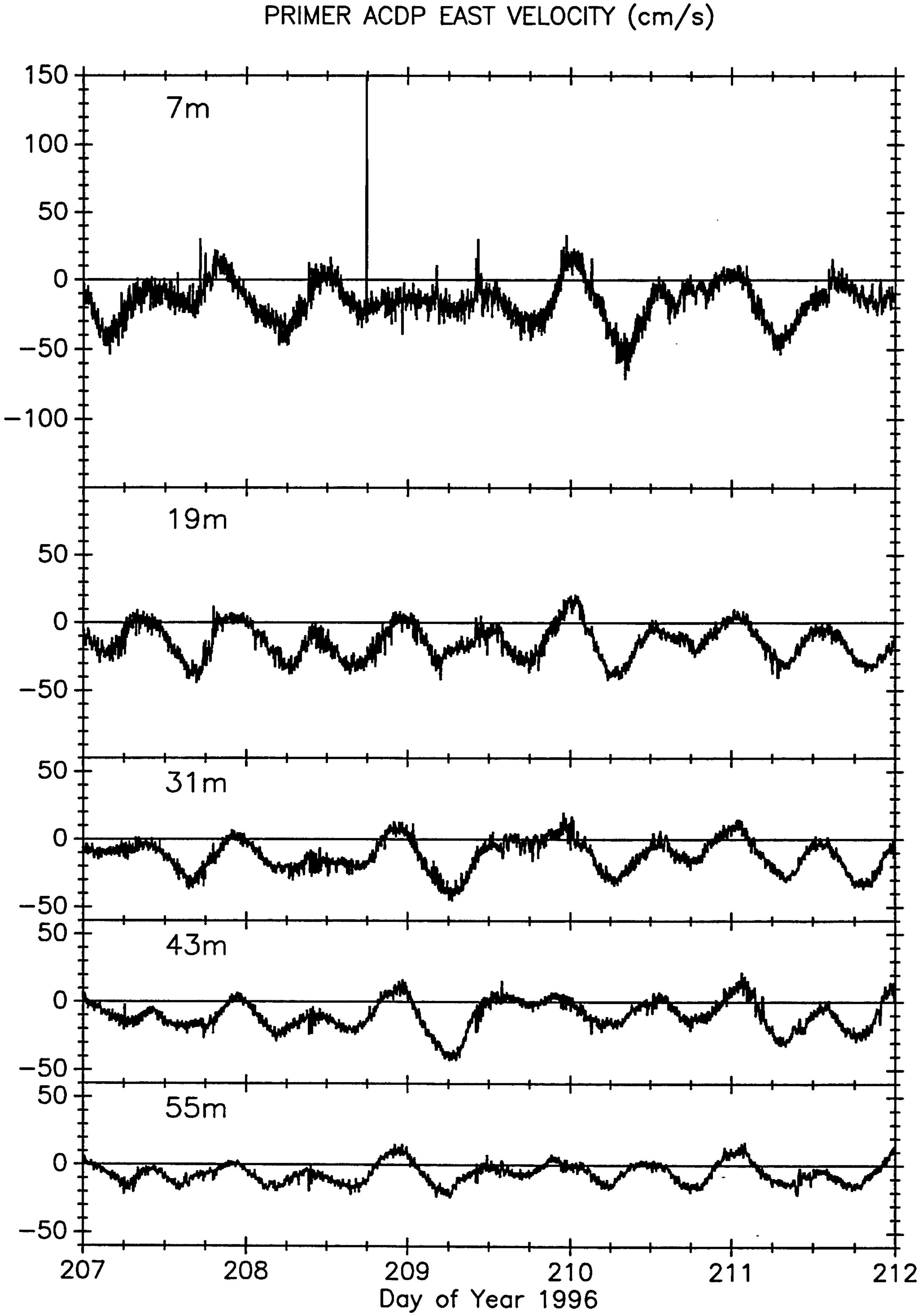
ADCP east component of velocity from 4-meter bins centered at 7 m, 19 m, 31 m, 43 m, and 55 m on the Main mooring. Velocity components are not filtered. The ADCP generates a vector-averaged velocity sample at two minute intervals.

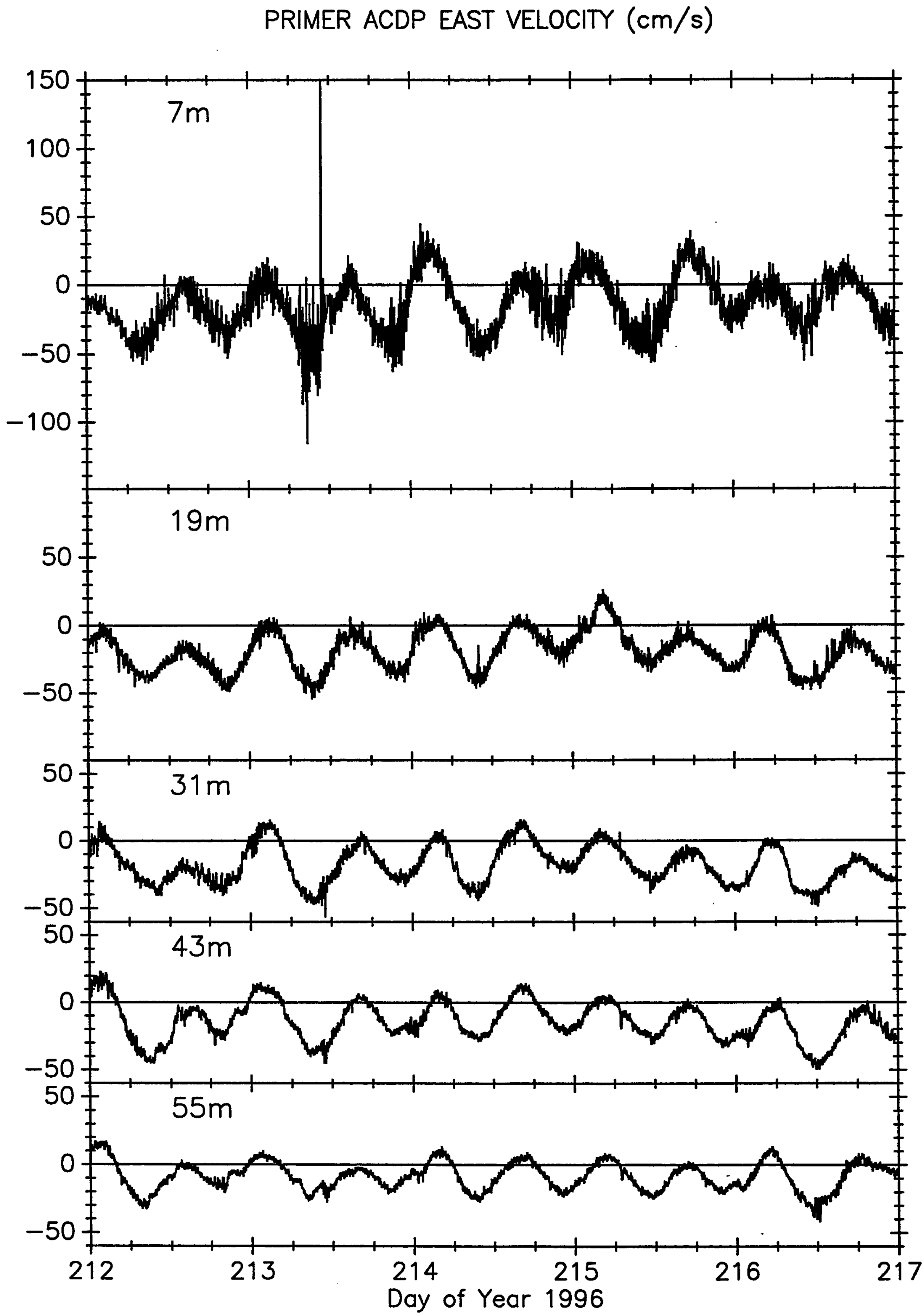

PRIMER ACDP EAST VELOCITY (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
−50
−100
192
193
194
195
196
197
Day of Year 1996

PRIMER ACDP EAST VELOCITY (cm/s)

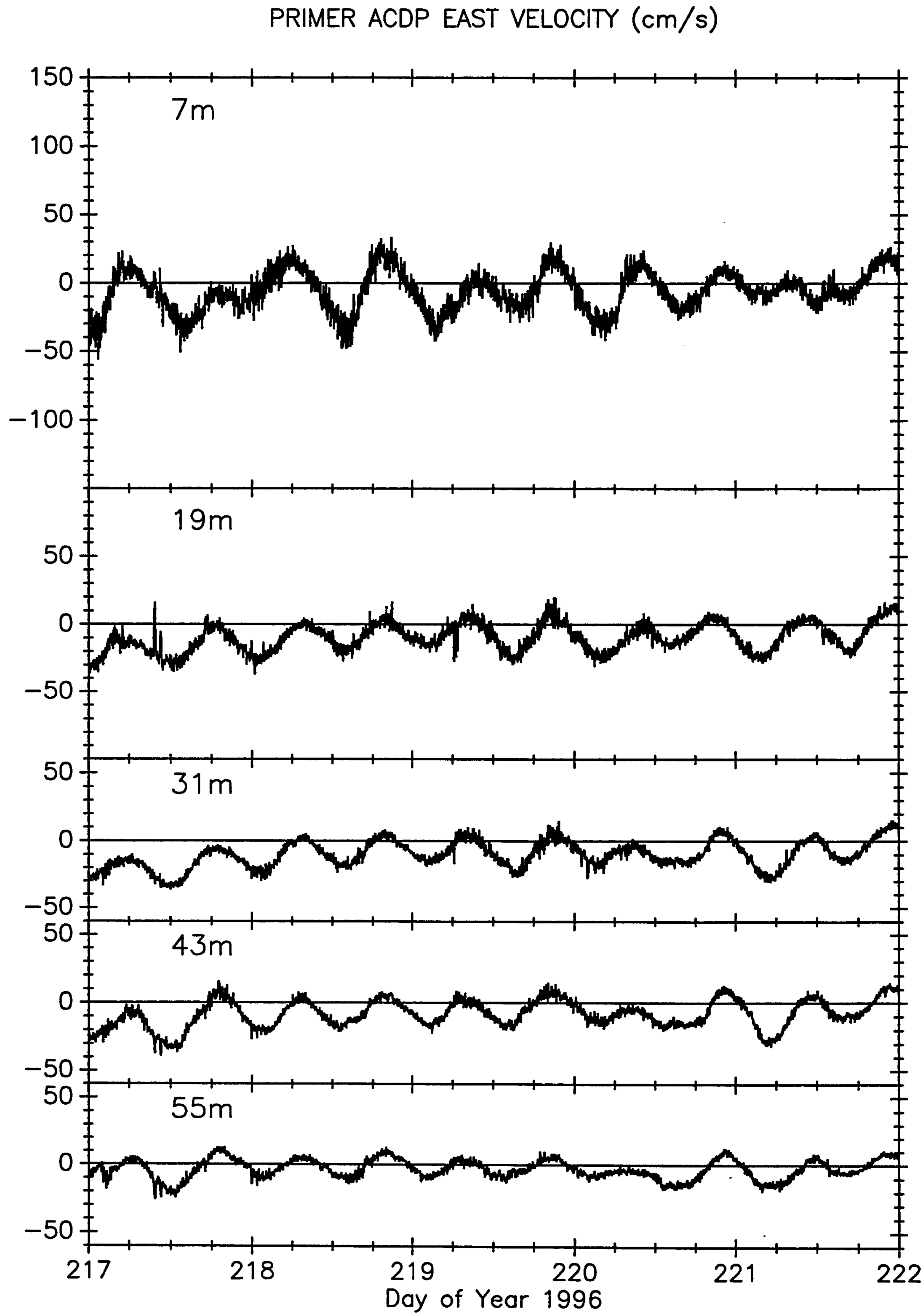


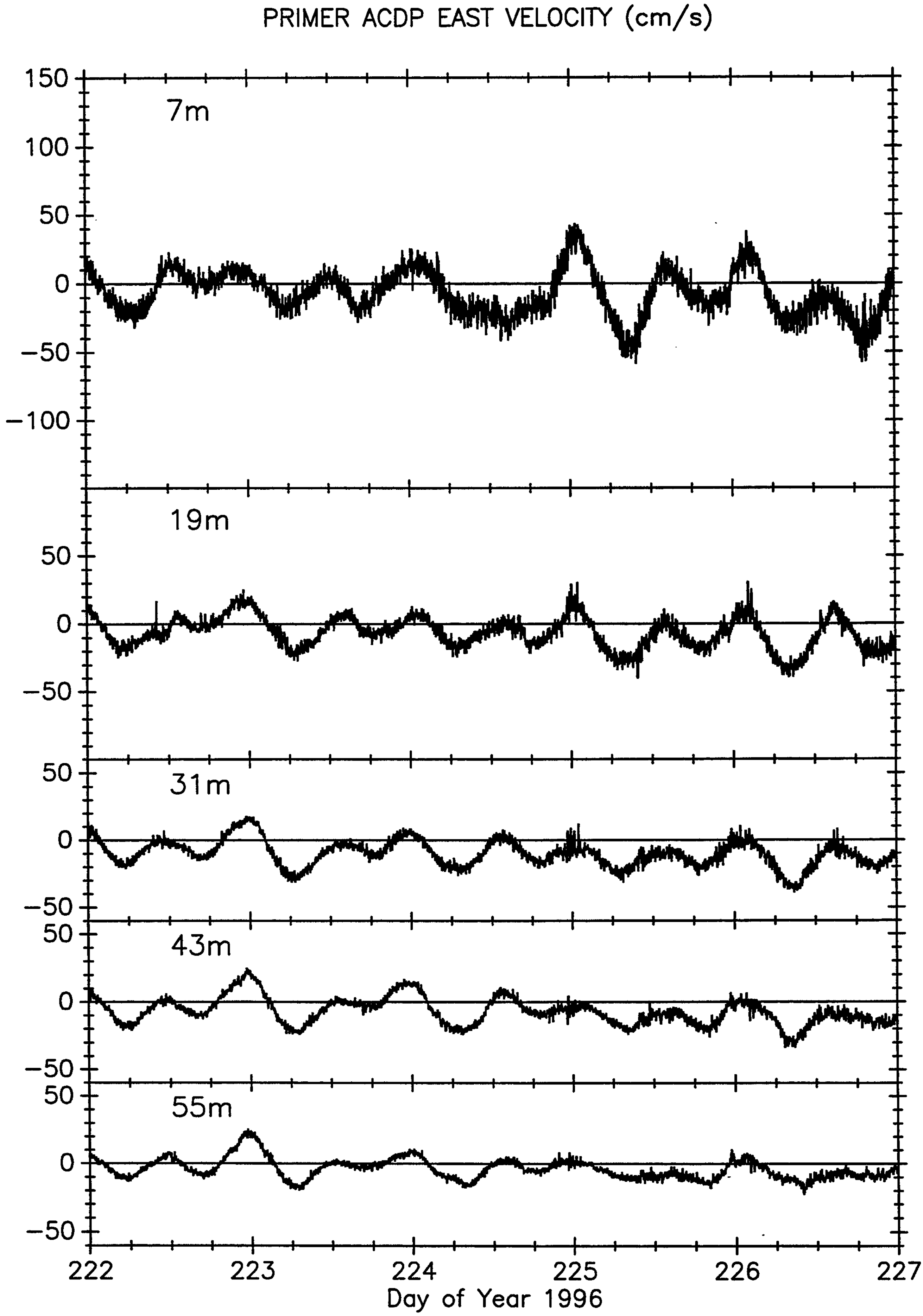

PRIMER ACDP EAST VELOCITY (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
−50
−100
202
203
204
205
206
207
Day of Year 1996

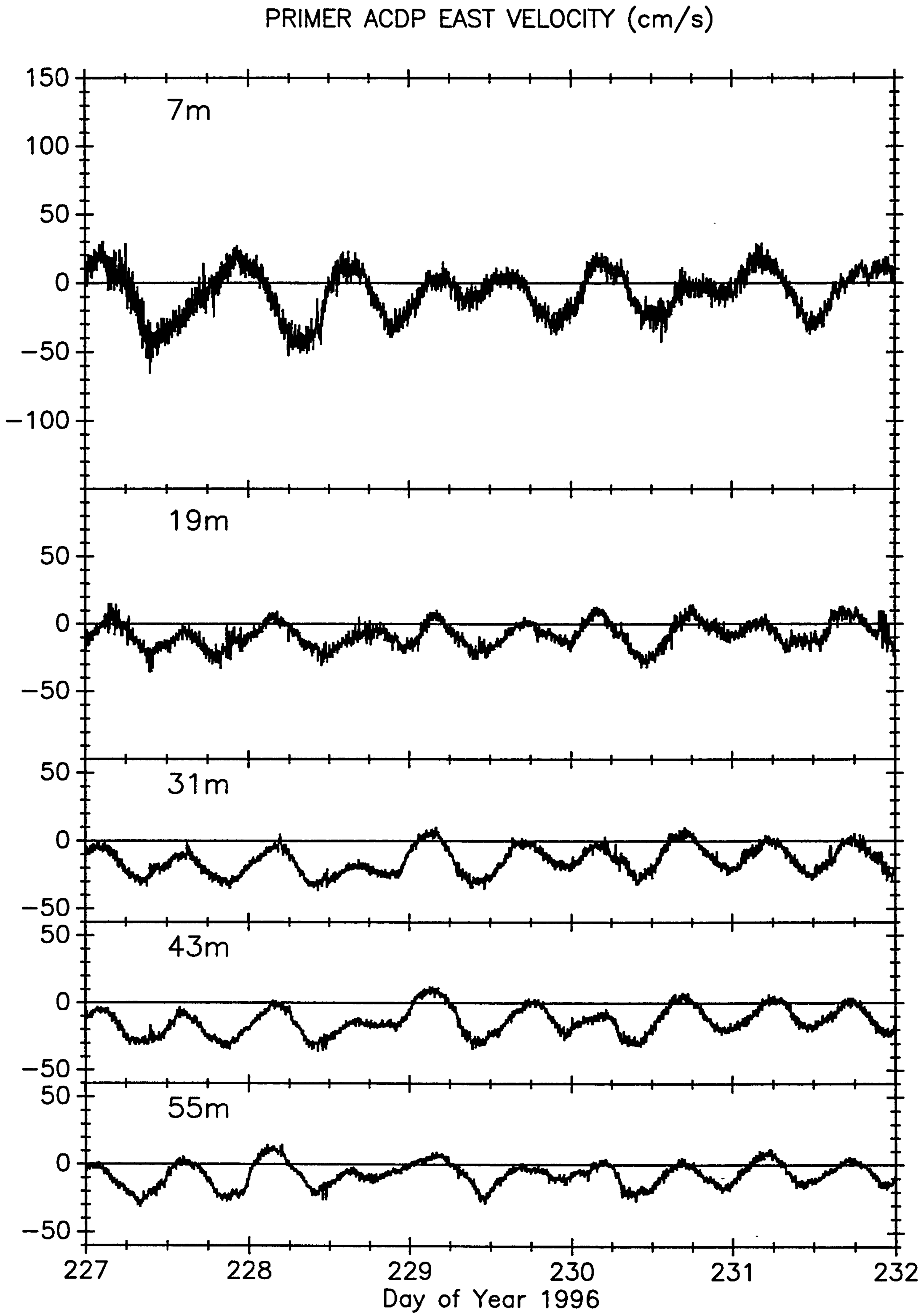

PRIMER ACDP EAST VELOCITY (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
−50
−100
207
208
209
210
211
212
Day of Year 1996

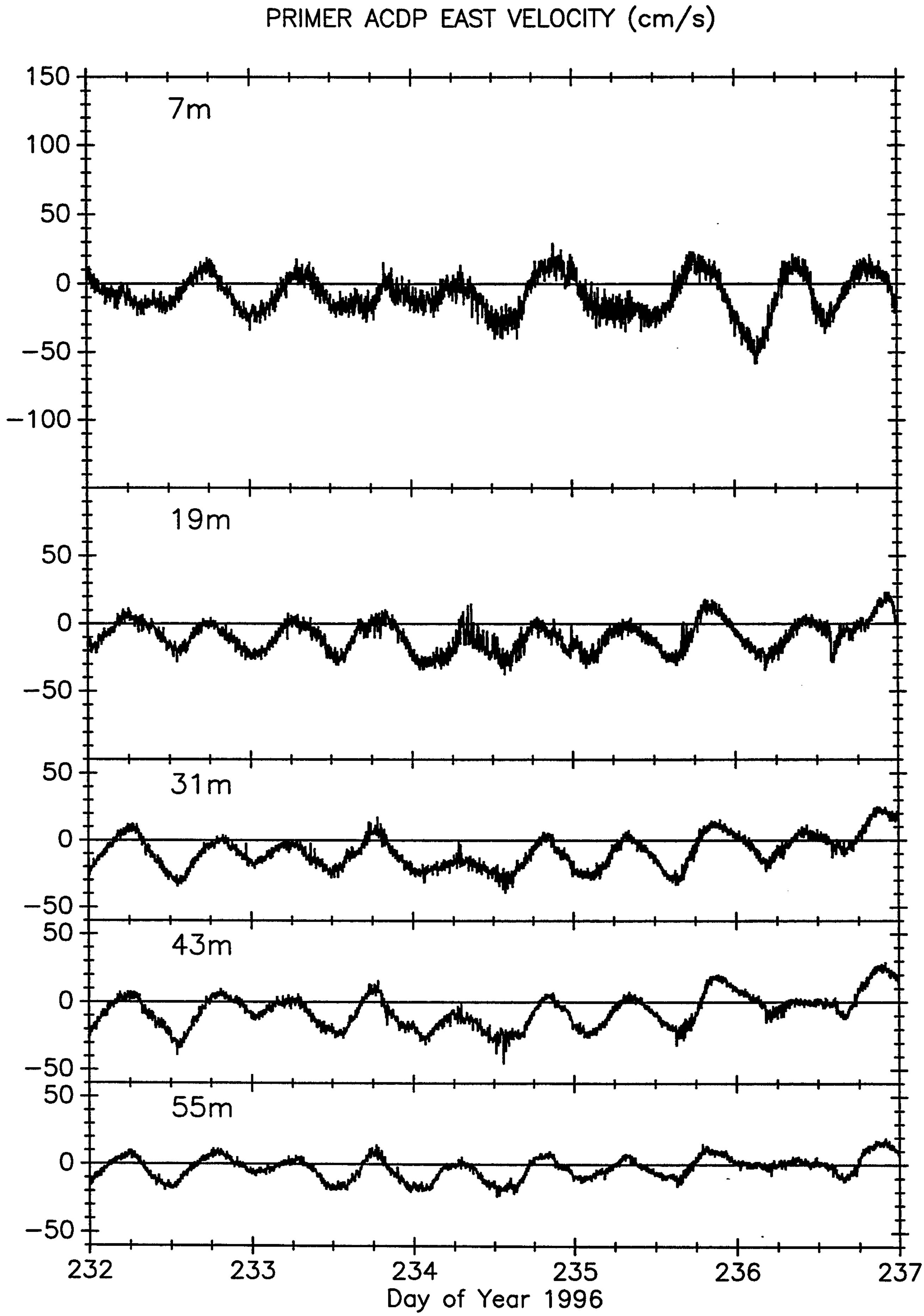


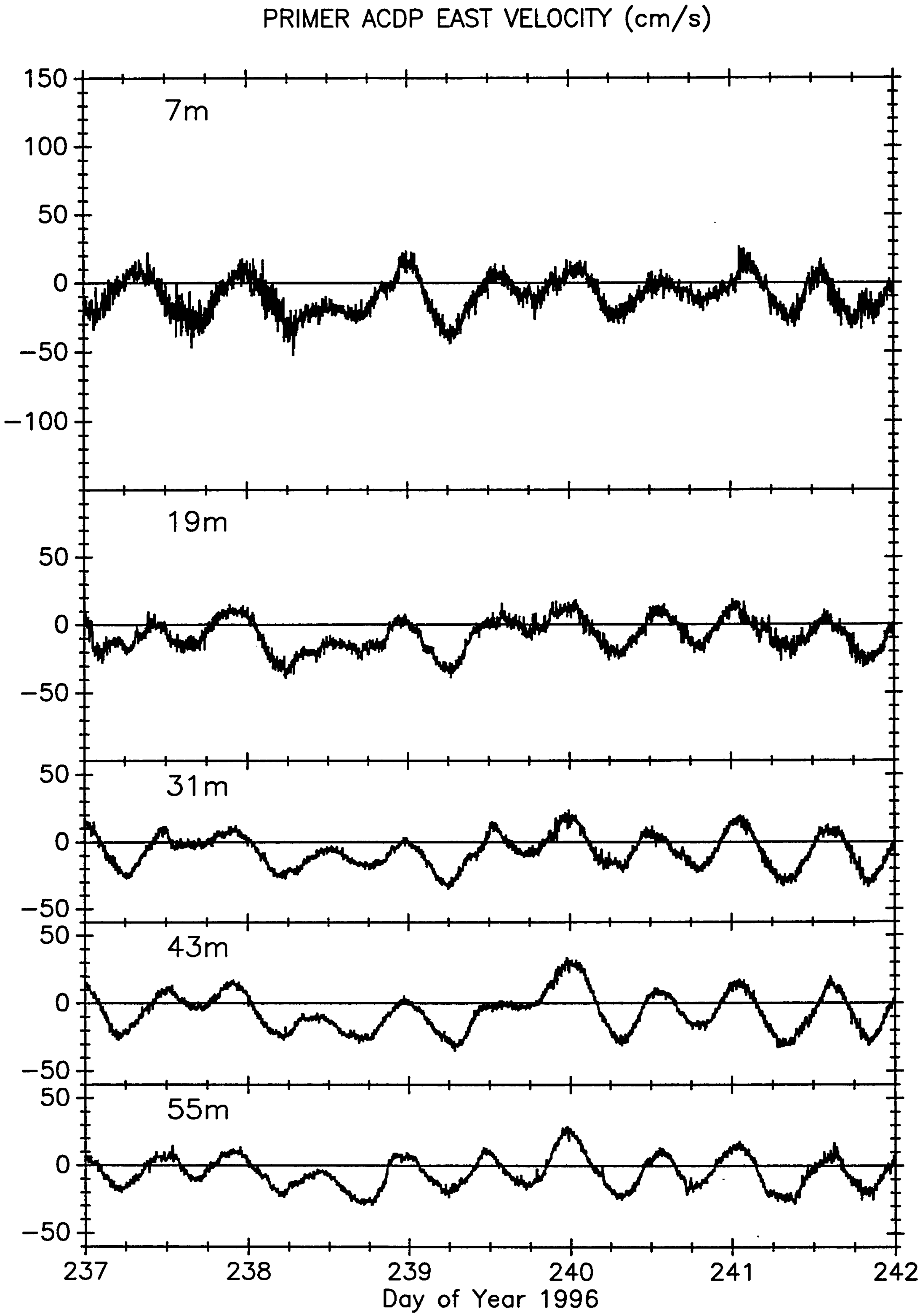
PRIMER ACDP EAST VELOCITY (cm/s)
150
100
50
0
−50
−100
7m
19m
31m
43m
55m
212
213
214
215
216
217
Day of Year 1996

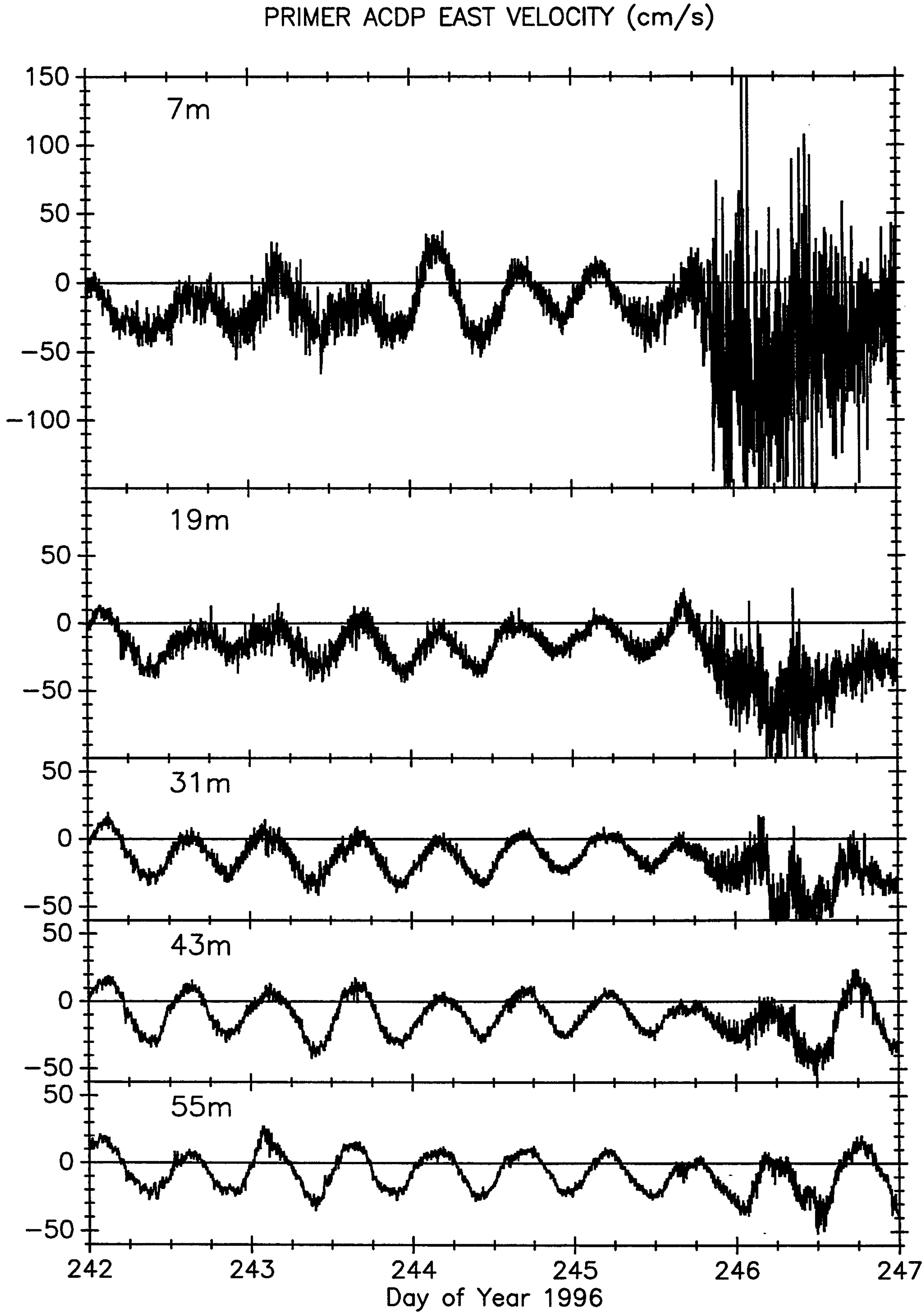

PRIMER ACDP EAST VELOCITY (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
−50
−100
217
218
219
220
221
222
Day of Year 1996

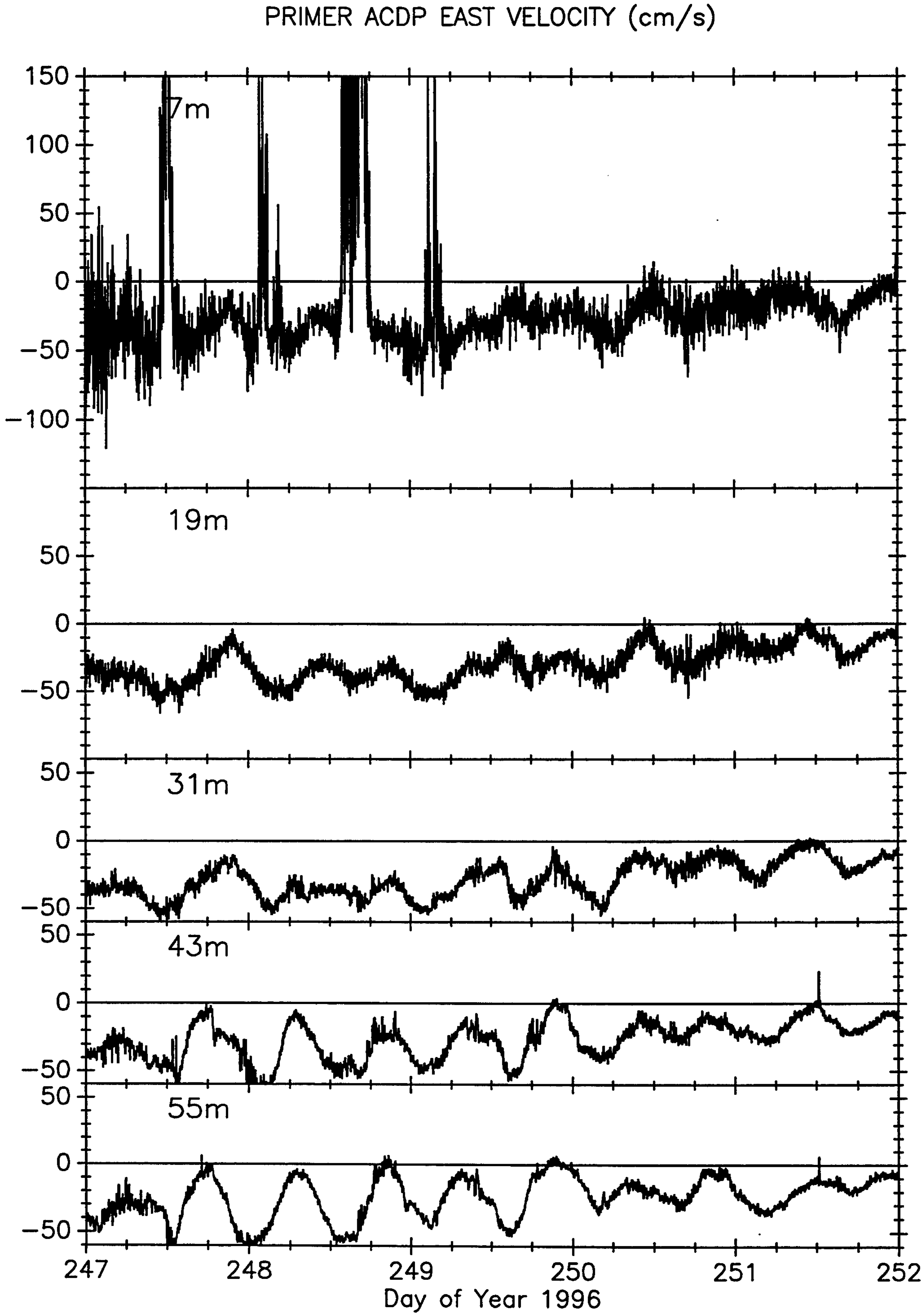

PRIMER ACDP EAST VELOCITY (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
−50
−100
222
223
224
225
226
227
Day of Year 1996

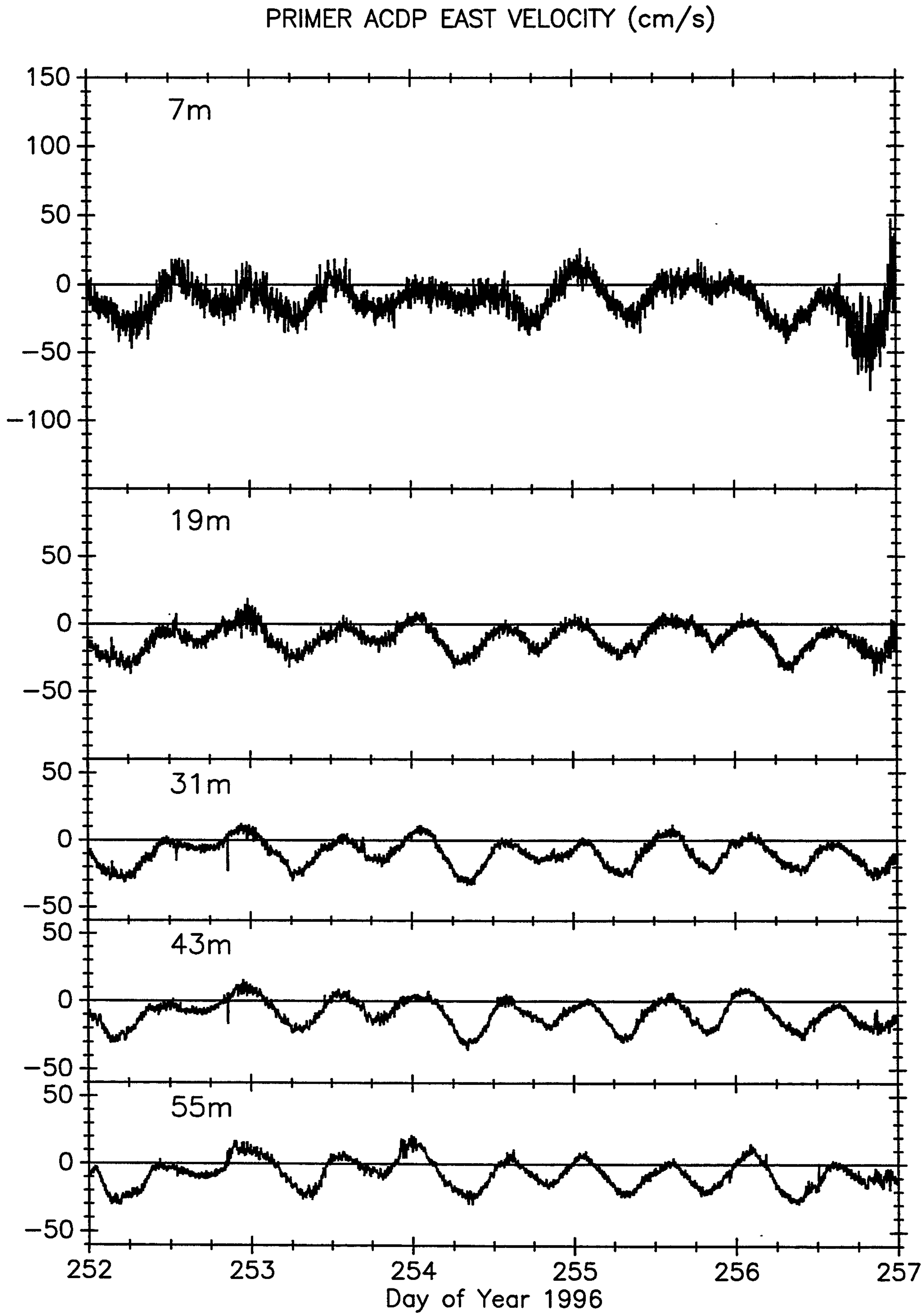

PRIMER ACDP EAST VELOCITY (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
−50
−100
227
228
229
230
231
232
Day of Year 1996

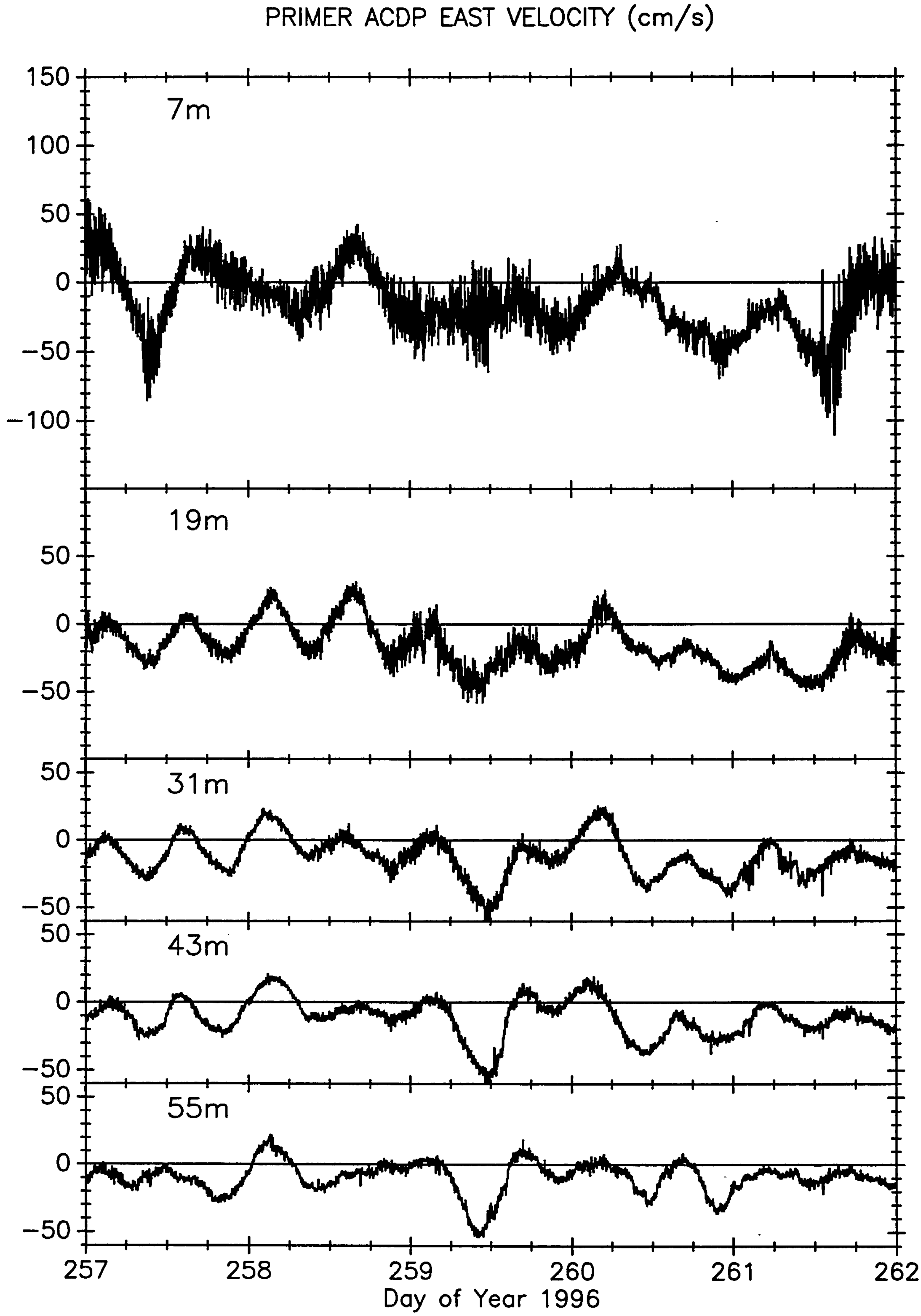

PRIMER ACDP EAST VELOCITY (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
−50
−100
232
233
234
235
236
237
Day of Year 1996


PRIMER ACDP EAST VELOCITY (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
−50
−100
237
238
239
240
241
242
Day of Year 1996

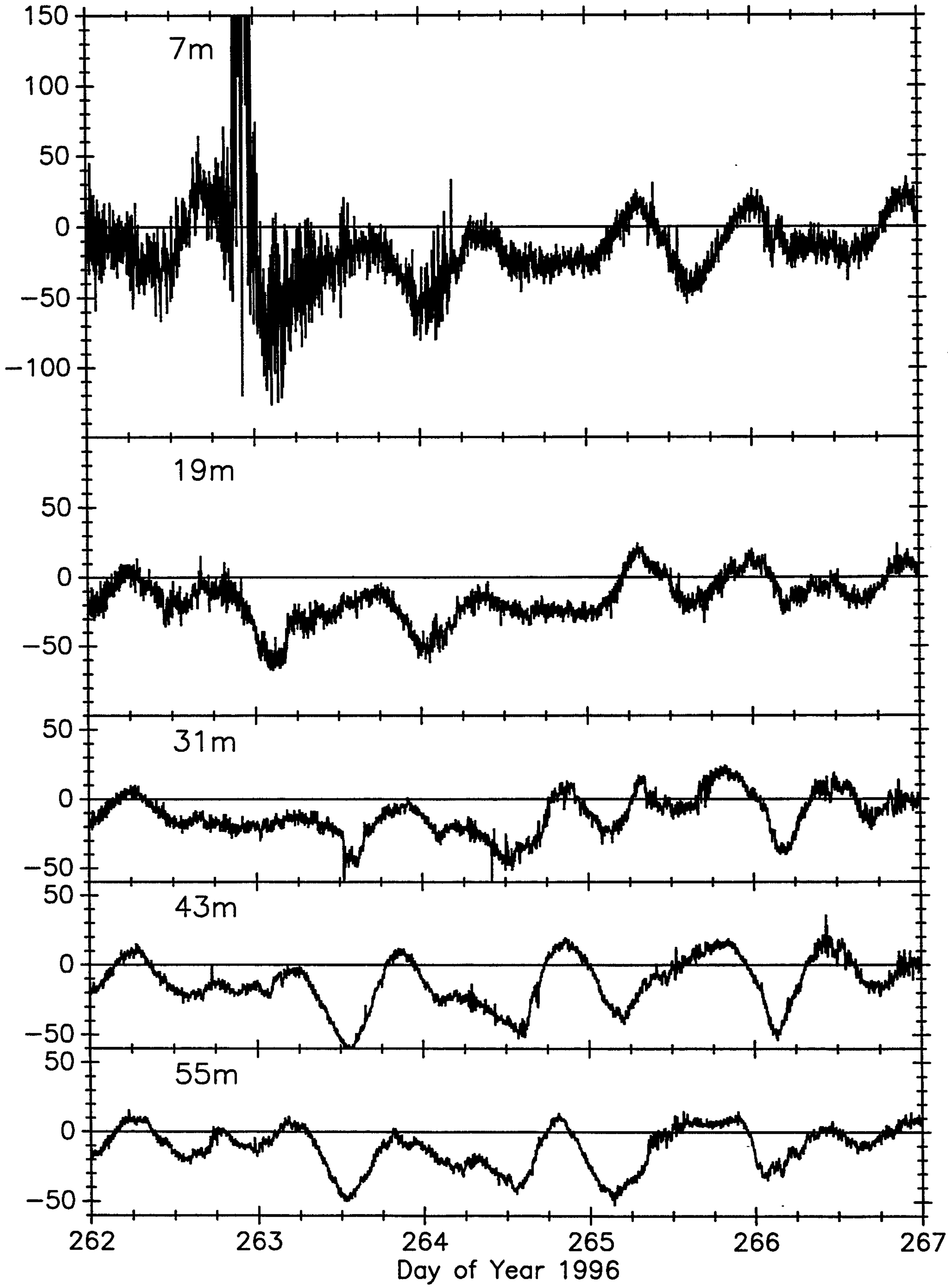

PRIMER ACDP EAST VELOCITY (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
−50
−100
242
243
244
245
246
247
Day of Year 1996

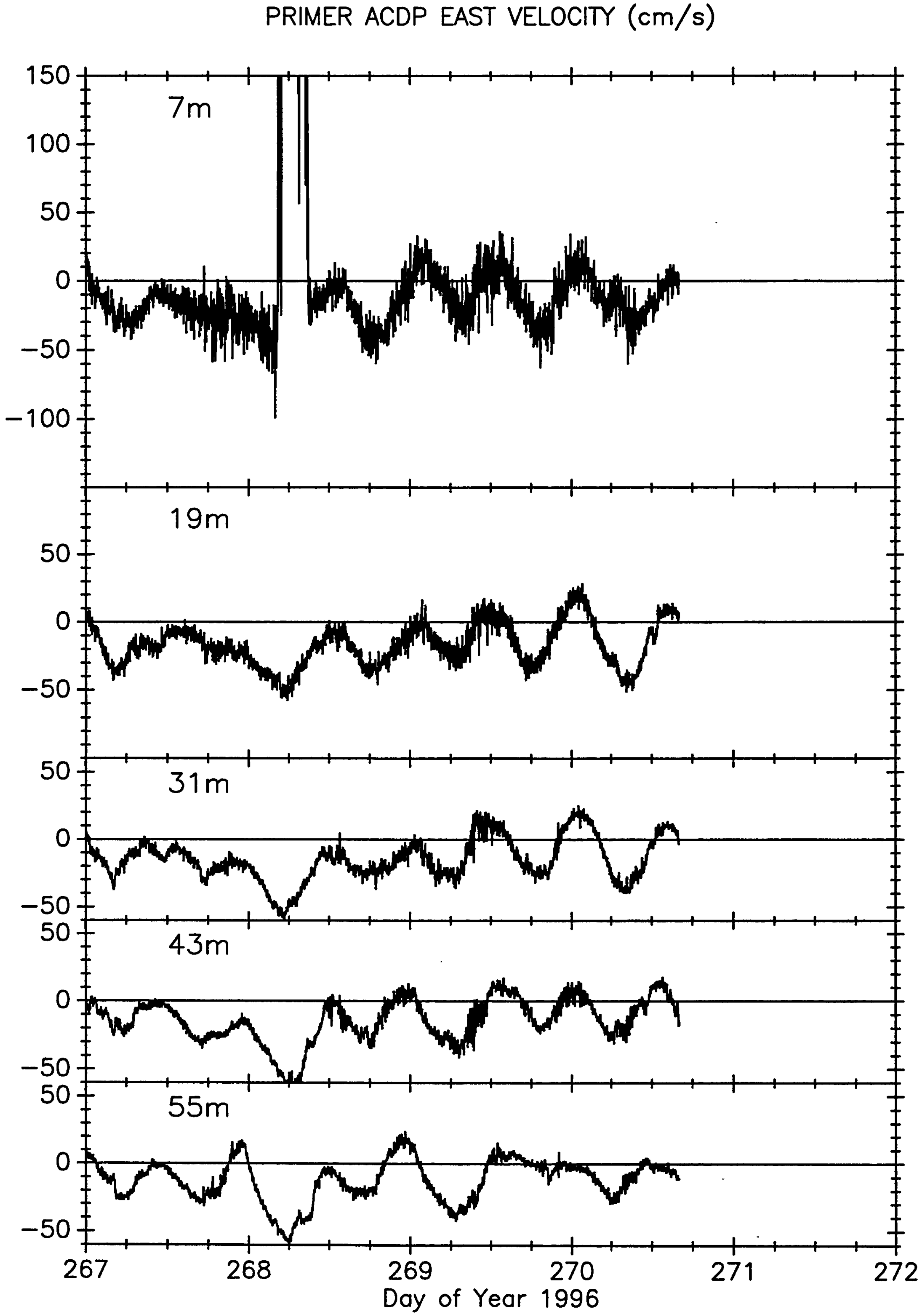

PRIMER ACDP EAST VELOCITY (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
−50
−100
247
248
249
250
251
252
Day of Year 1996


PRIMER ACDP EAST VELOCITY (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
−50
−100
252
253
254
255
256
257
Day of Year 1996


PRIMER ACDP EAST VELOCITY (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
−50
−100
257
258
259
260
261
262
Day of Year 1996

PRIMER ACDP EAST VELOCITY (cm/s)




PRIMER ACDP EAST VELOCITY (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
−50
−100
267
268
269
270
271
272
Day of Year 1996

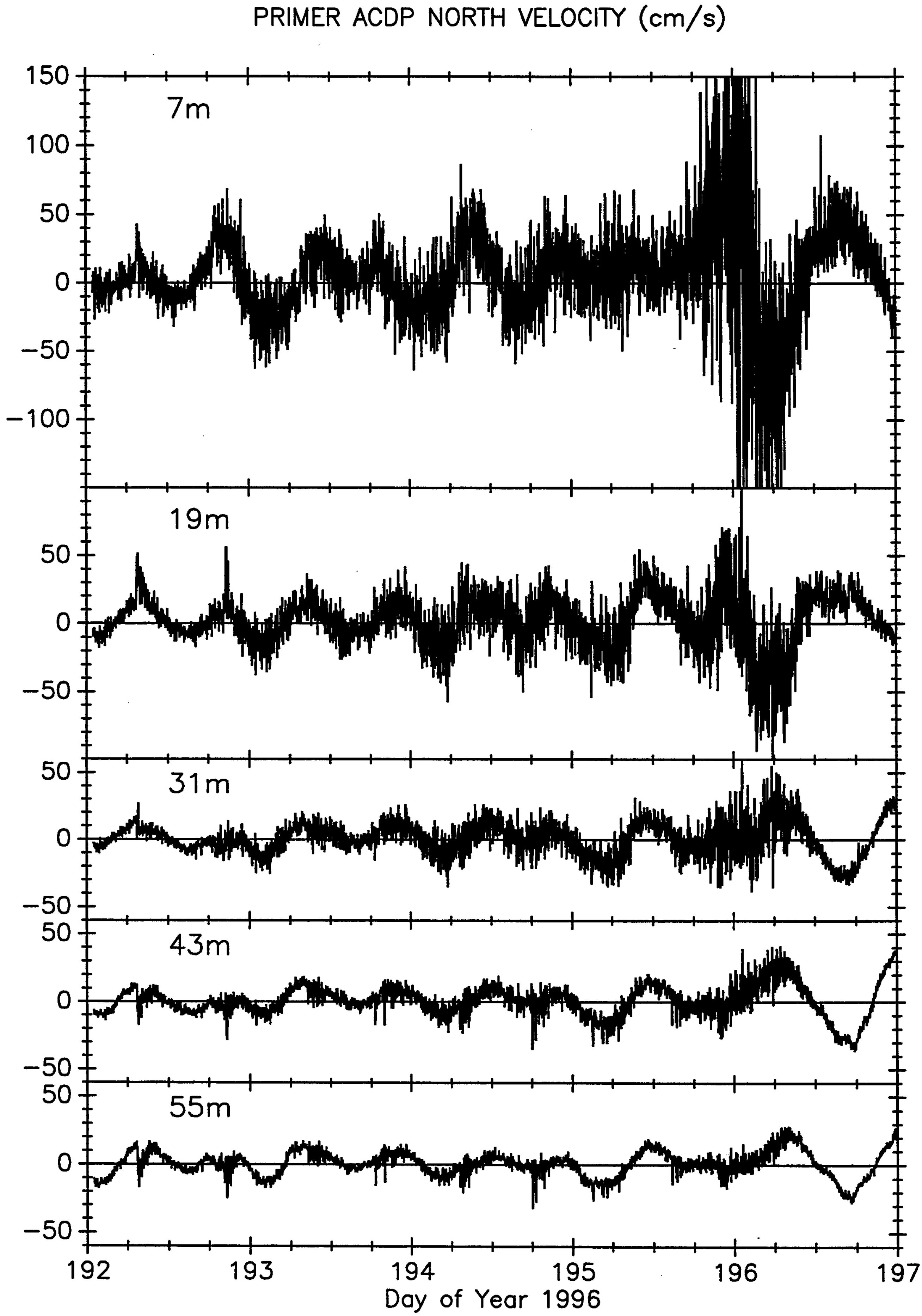
VELOCITY (ADCP) Time Series

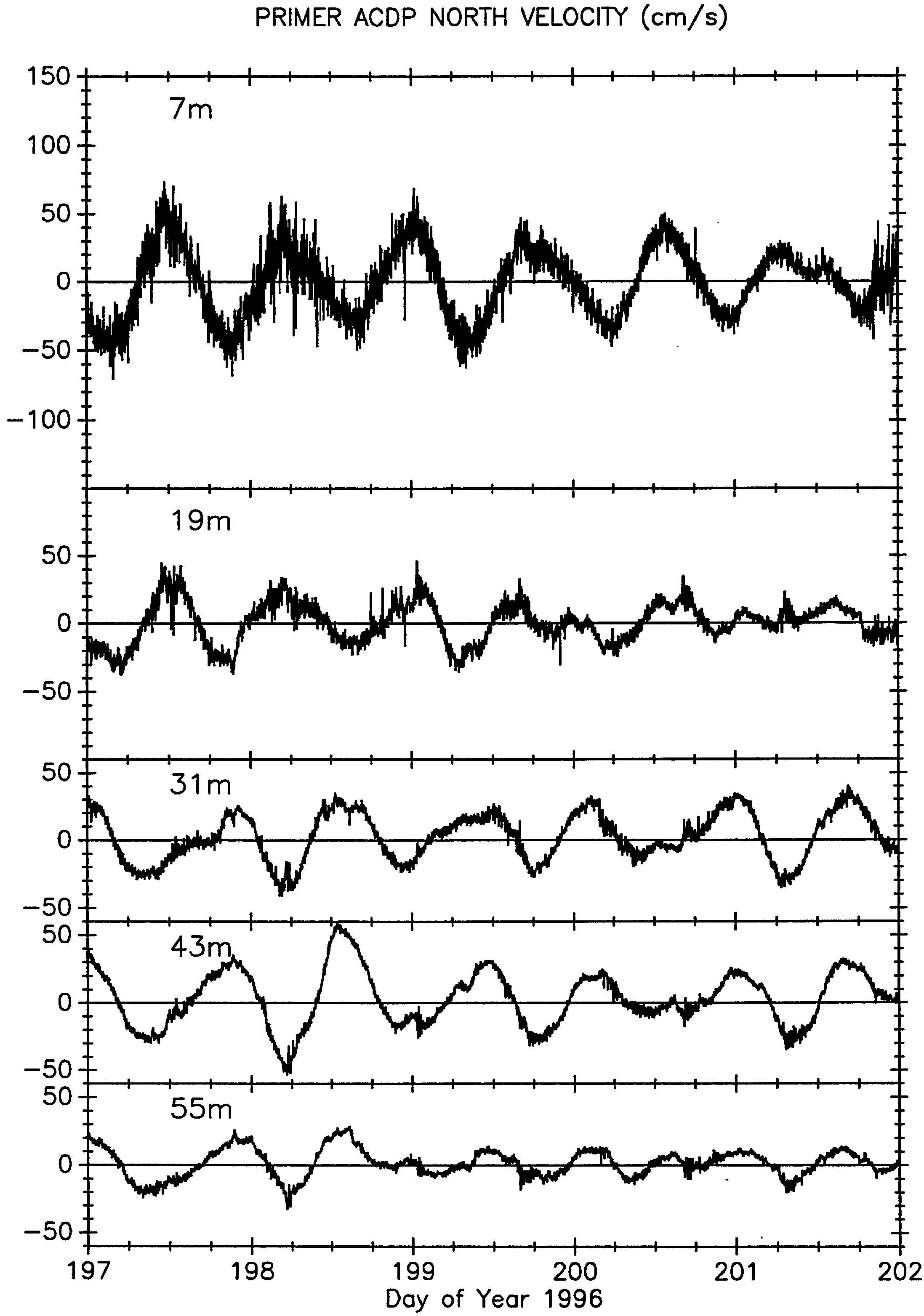
North Component

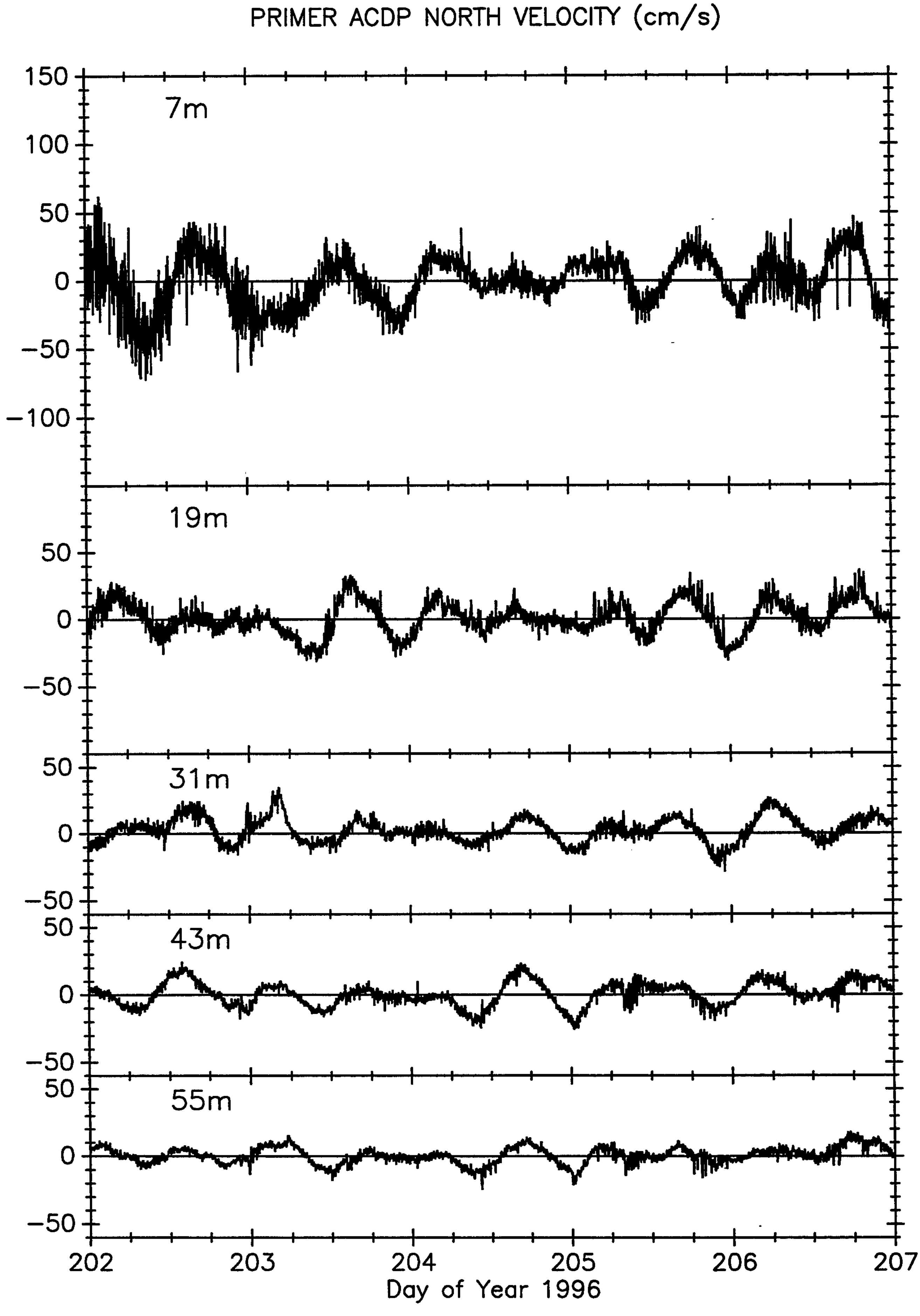
Main Mooring

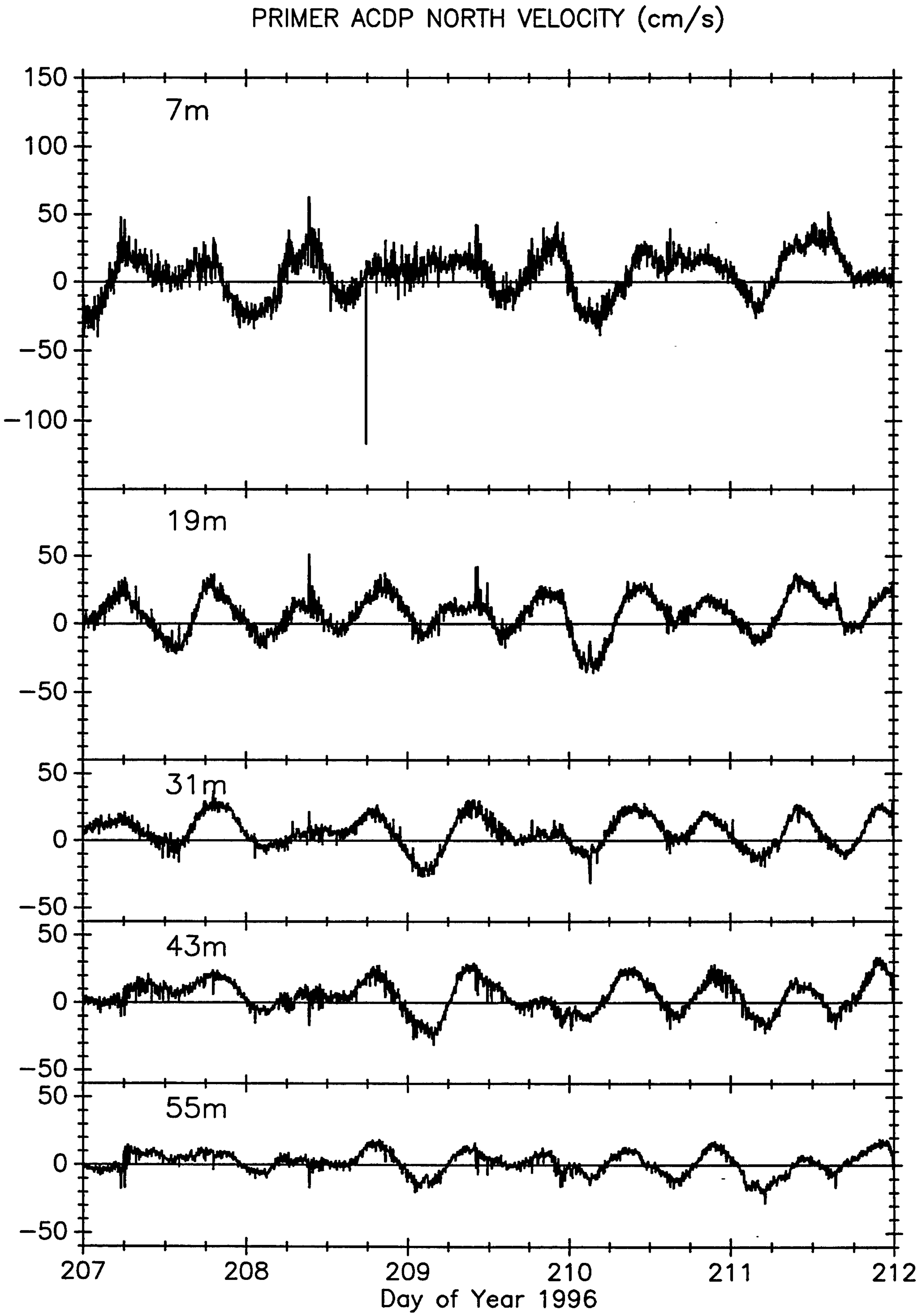
Unfiltered

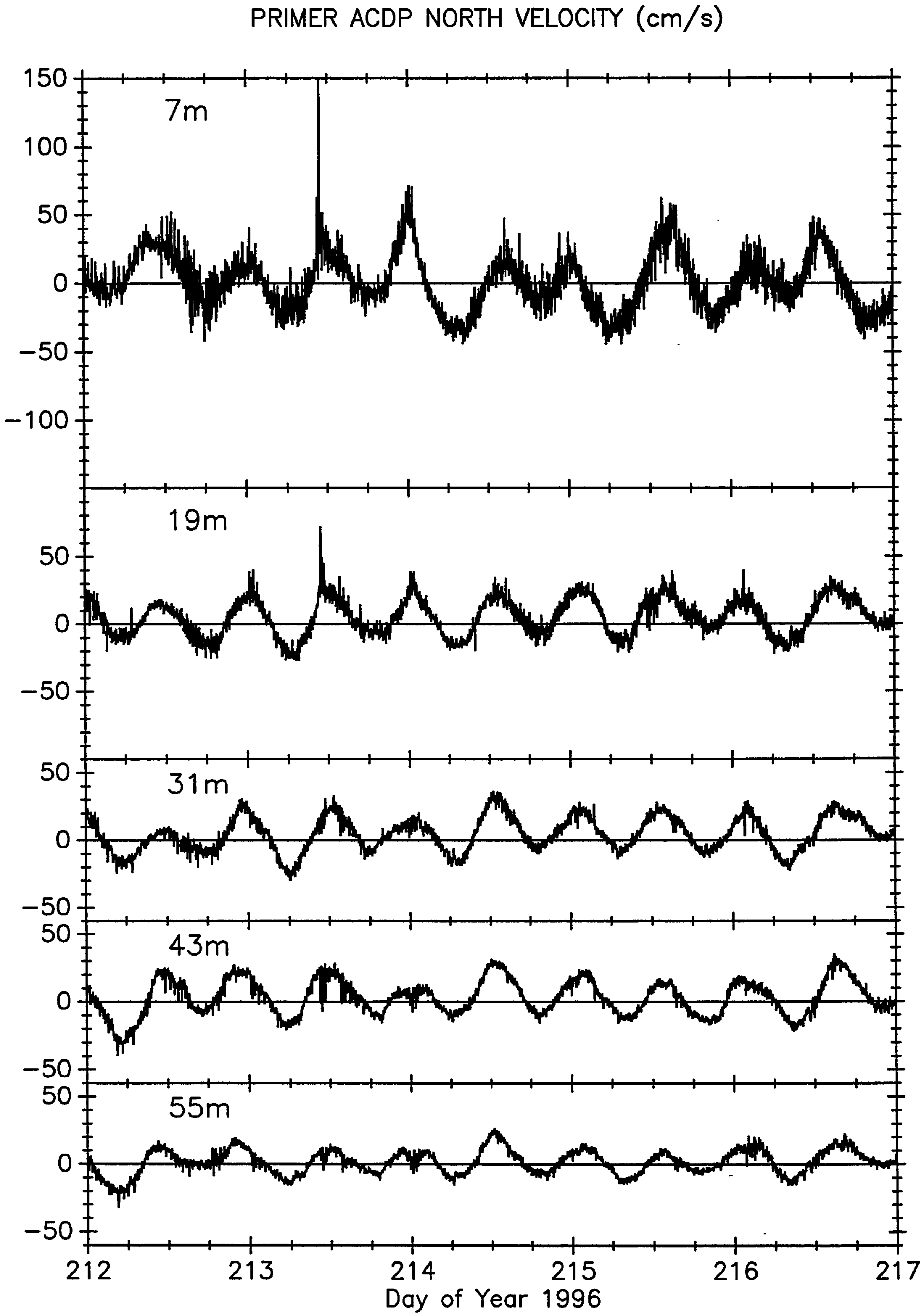
ADCP north component of velocity from 4-meter bins centered at 7 m, 19 m, 31 m, 43 m, and 55 m on the Main mooring. Velocity components are not filtered. The ADCP generates a vector-averaged velocity sample at two minute intervals.

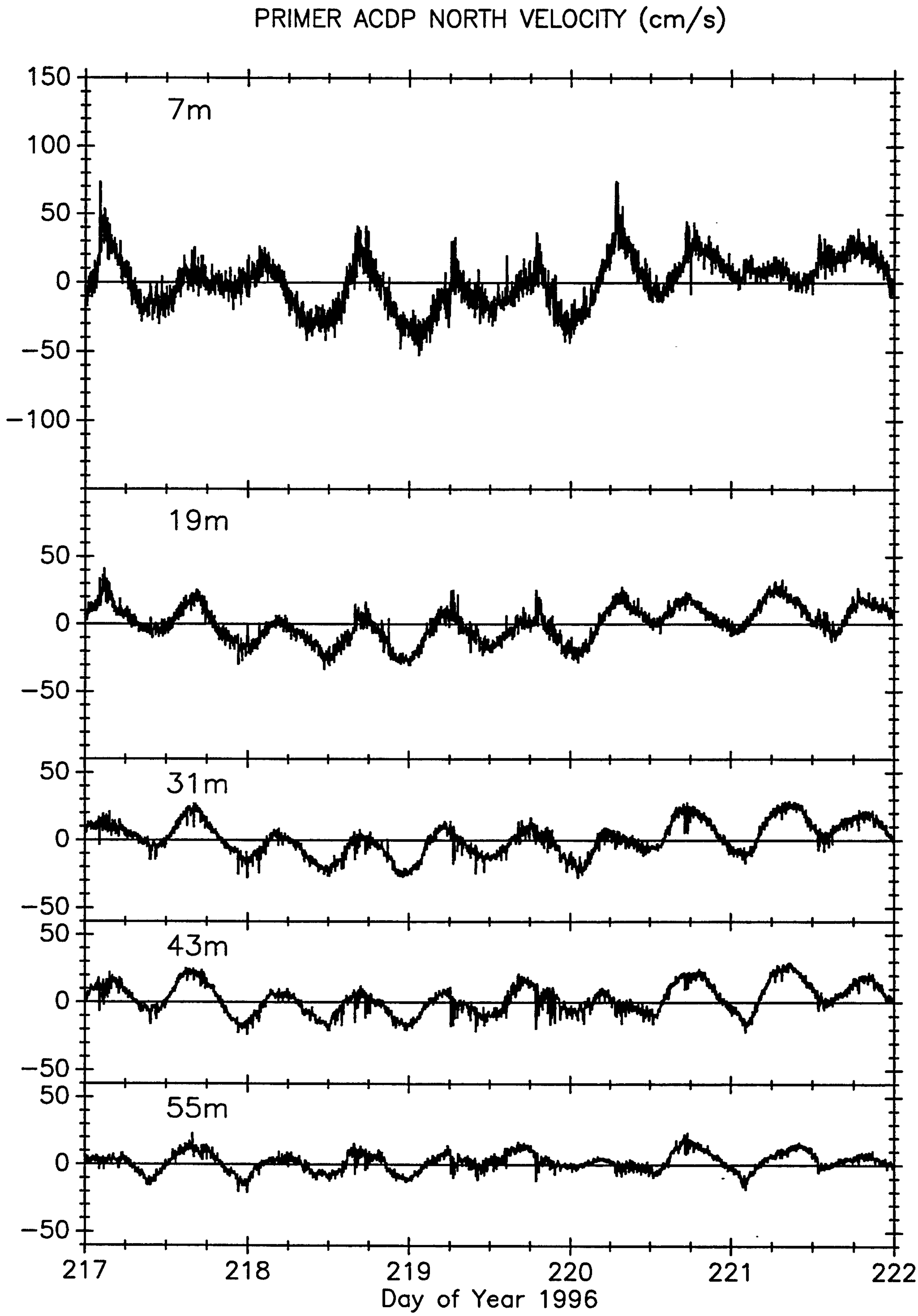

PRIMER ACDP NORTH VELOCITY (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
−50
−100
192
193
194
195
196
197
Day of Year 1996

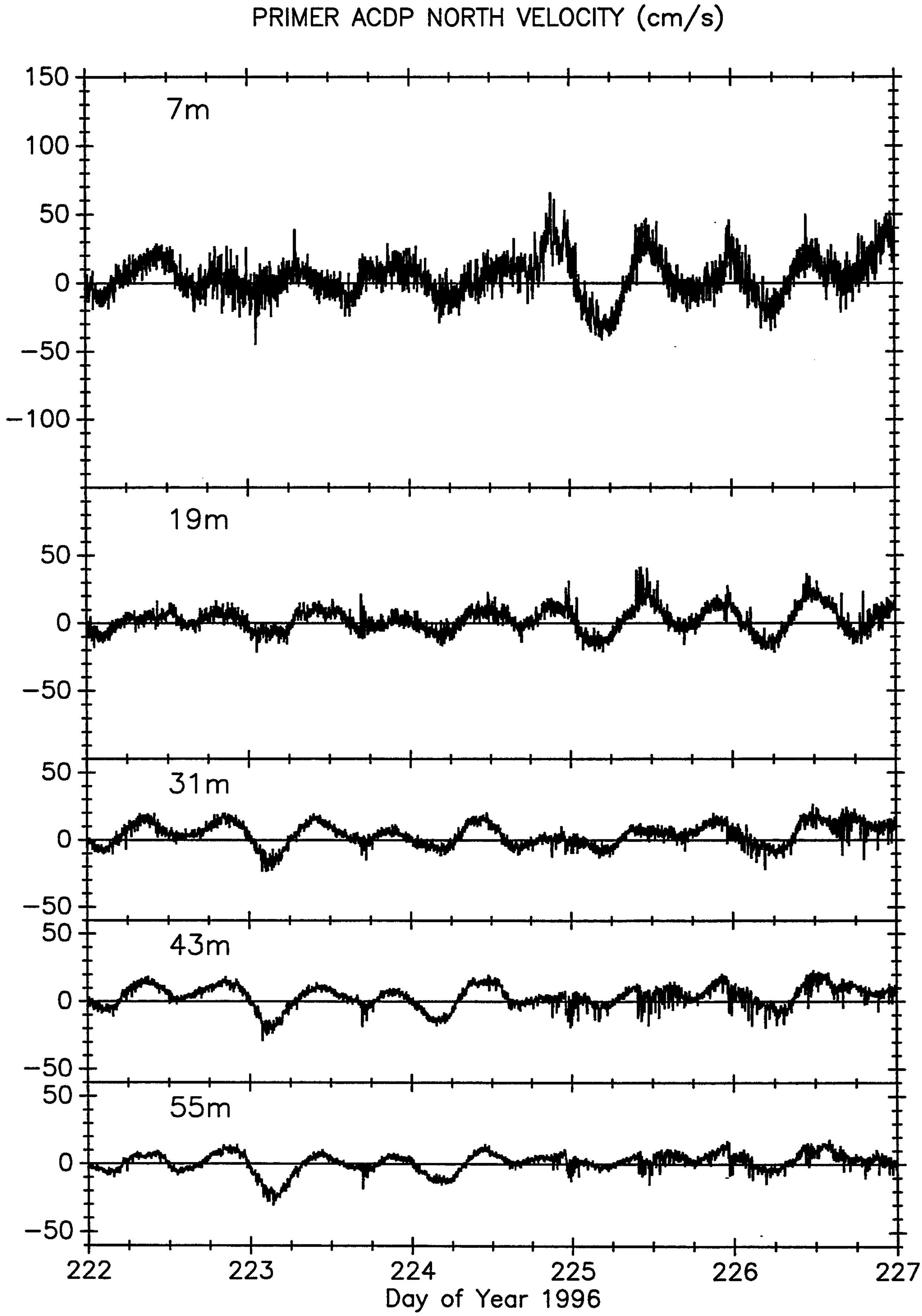

PRIMER ACDP NORTH VELOCITY (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
−50
−100
197
198
199
200
201
202
Day of Year 1996

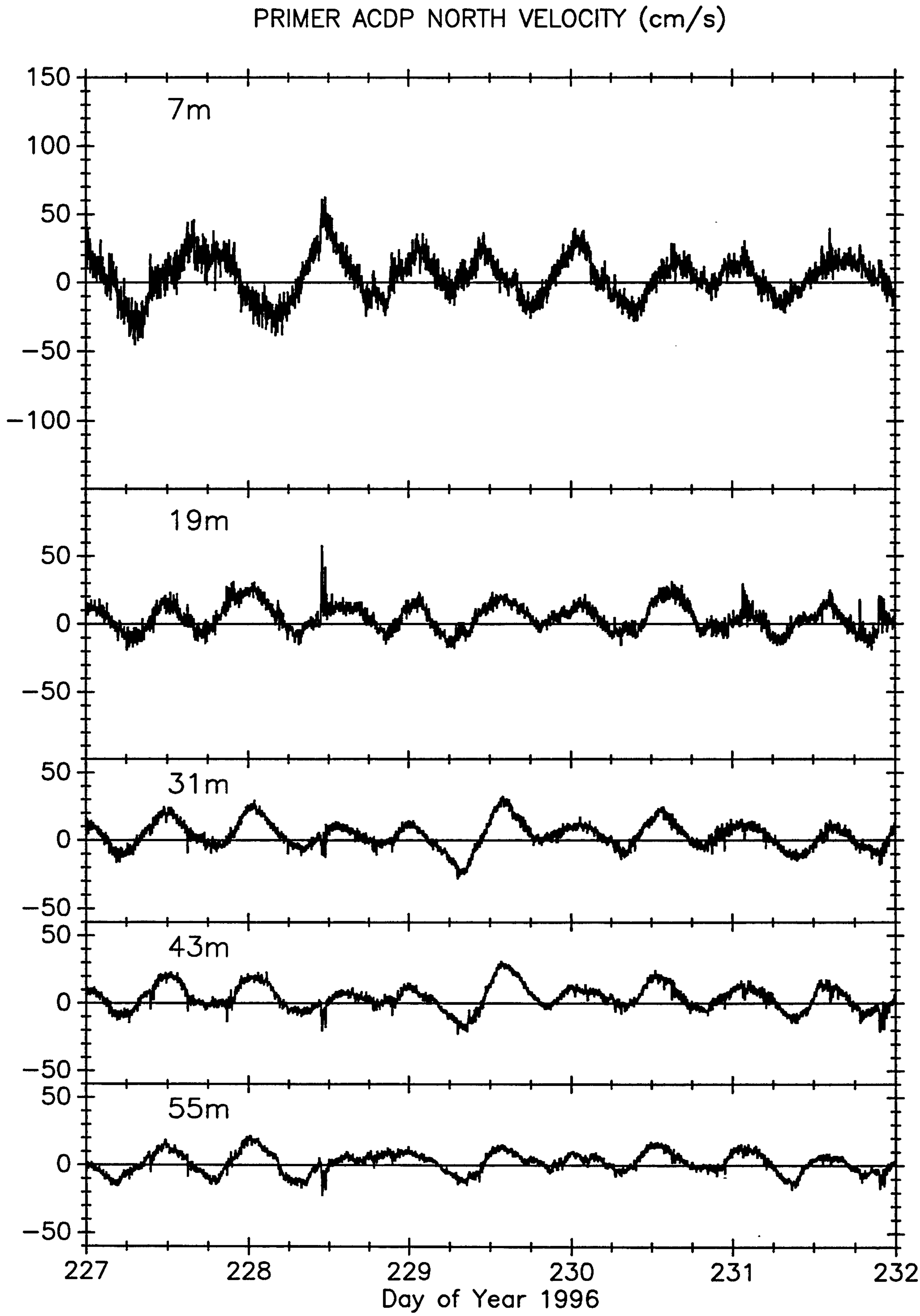

PRIMER ACDP NORTH VELOCITY (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
−50
−100
202
203
204
205
206
207
Day of Year 1996

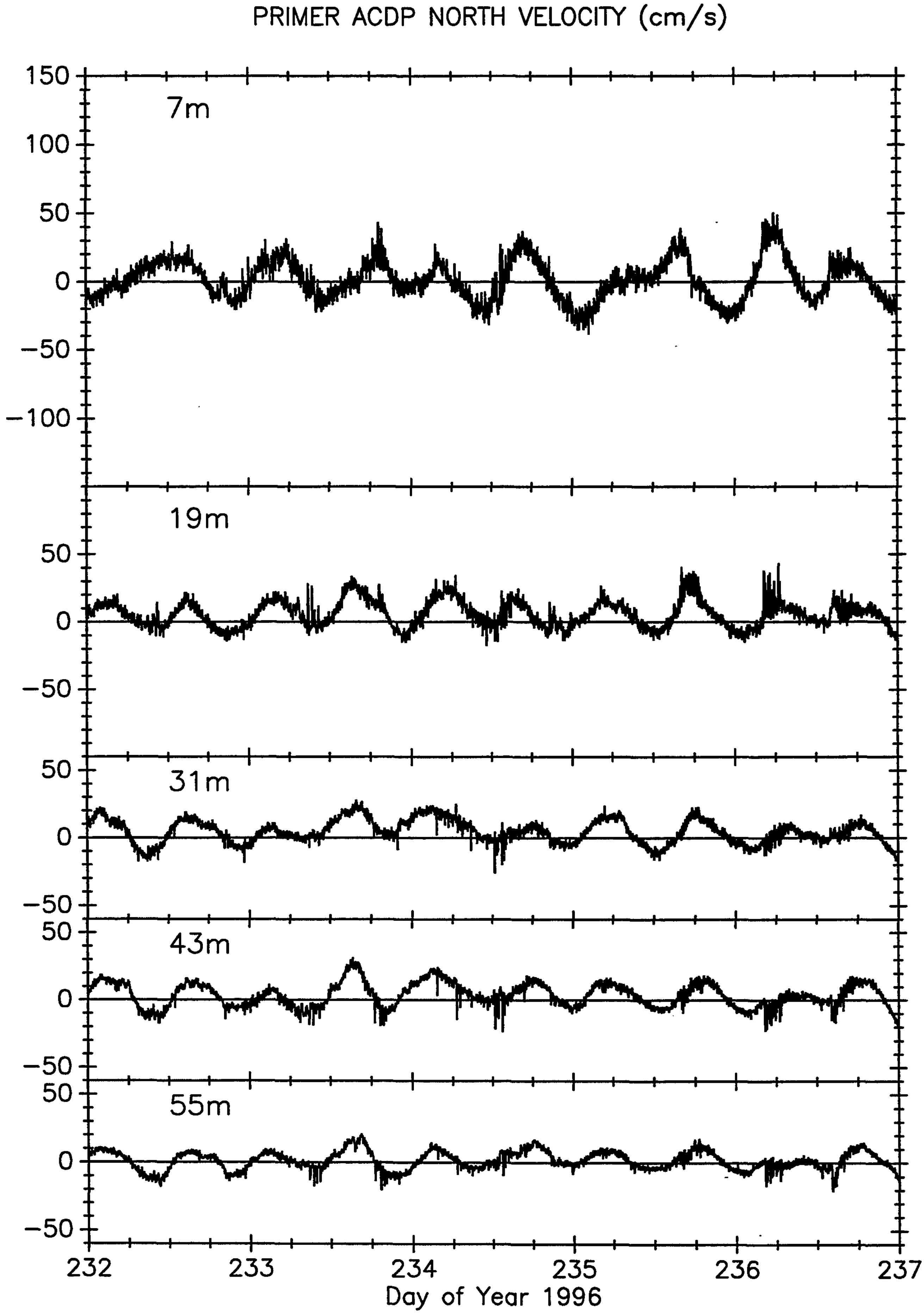

PRIMER ACDP NORTH VELOCITY (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
−50
−100
207
208
209
210
211
212
Day of Year 1996

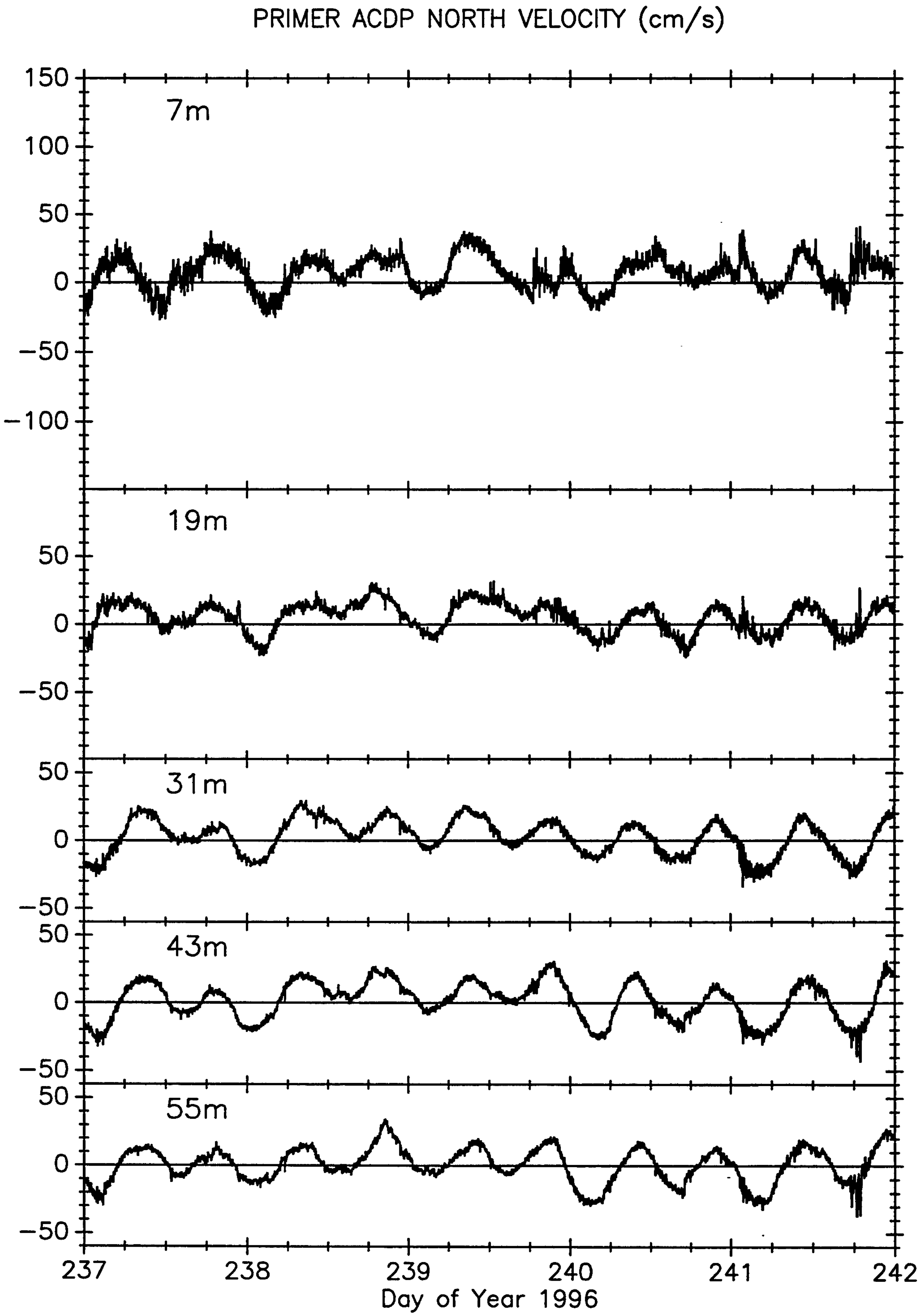

PRIMER ACDP NORTH VELOCITY (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
−50
−100
212
213
214
215
216
217
Day of Year 1996

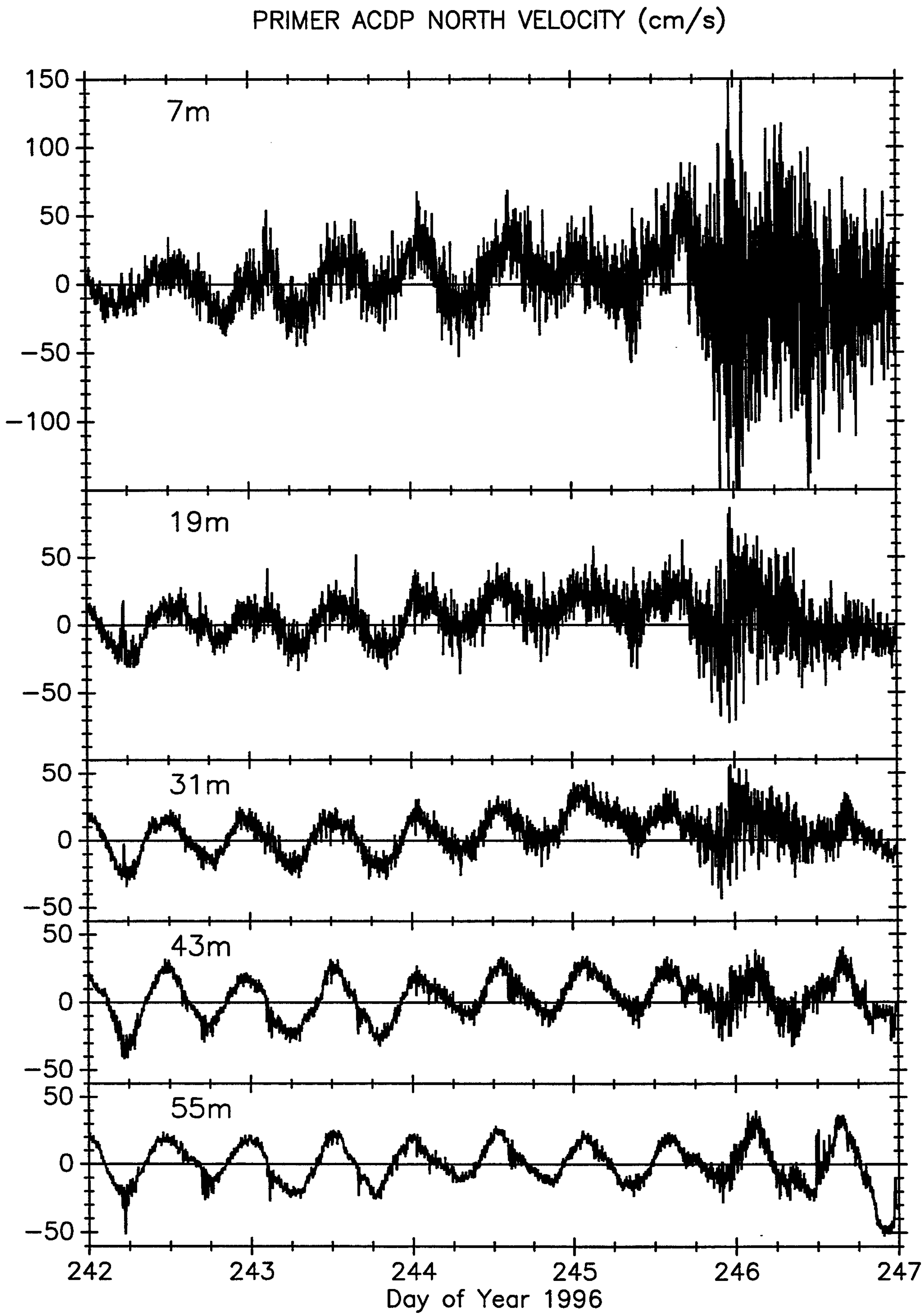

PRIMER ACDP NORTH VELOCITY (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
−50
−100
217
218
219
220
221
222
Day of Year 1996

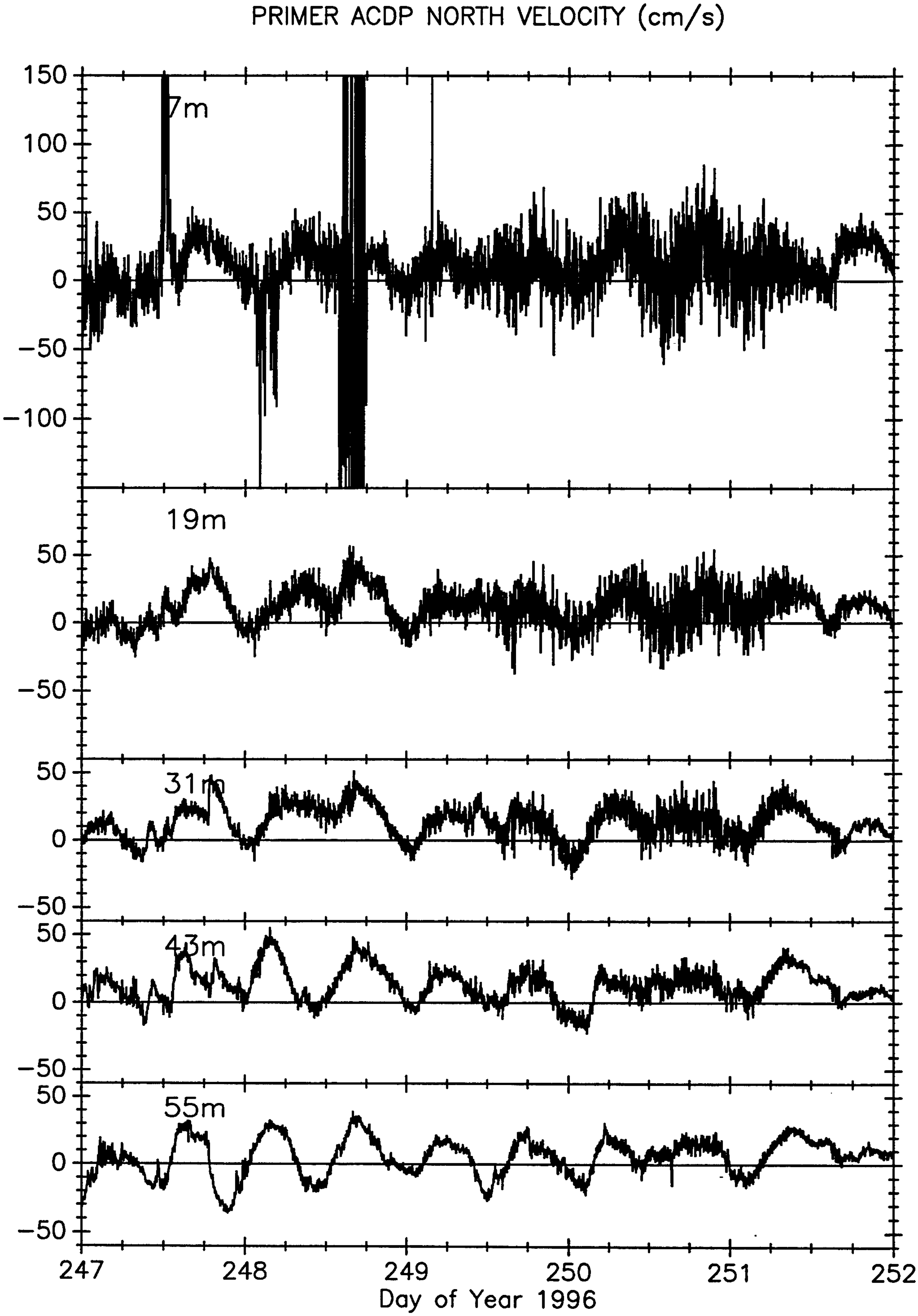

PRIMER ACDP NORTH VELOCITY (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
−50
−100
222
223
224
225
226
227
Day of Year 1996

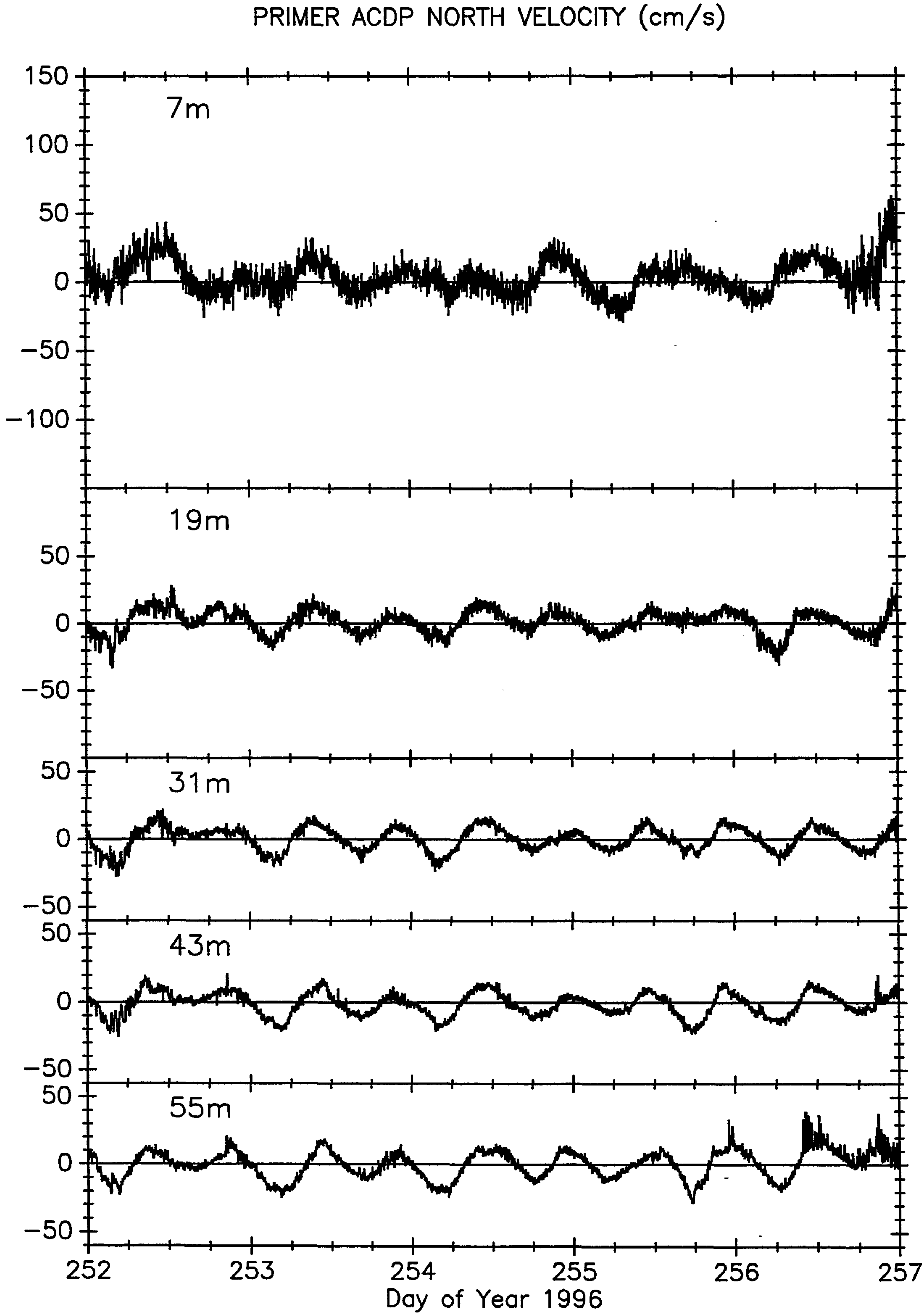

PRIMER ACDP NORTH VELOCITY (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
−50
−100
227
228
229
230
231
232
Day of Year 1996

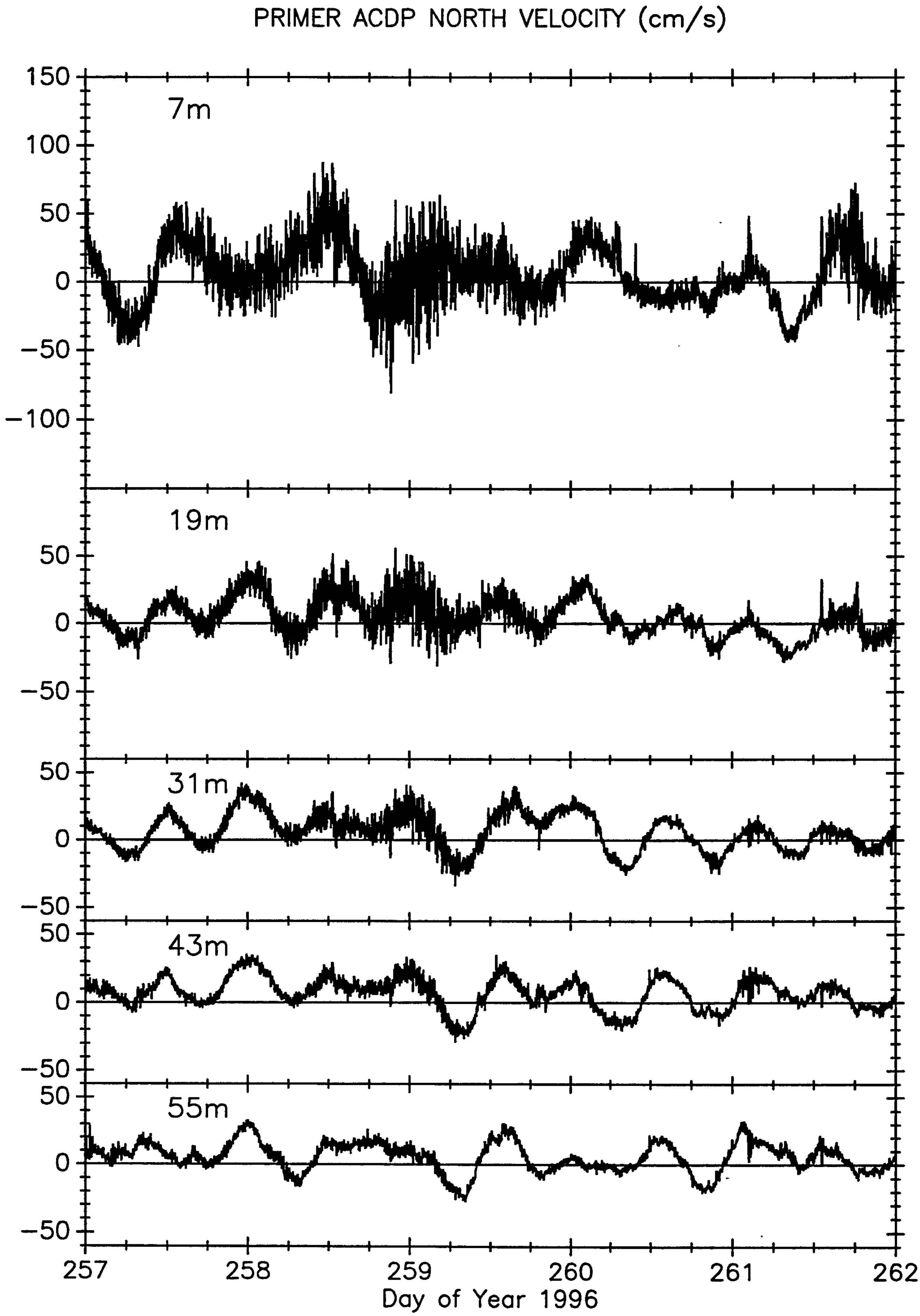

PRIMER ACDP NORTH VELOCITY (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
−50
−100
232
233
234
235
236
237
Day of Year 1996

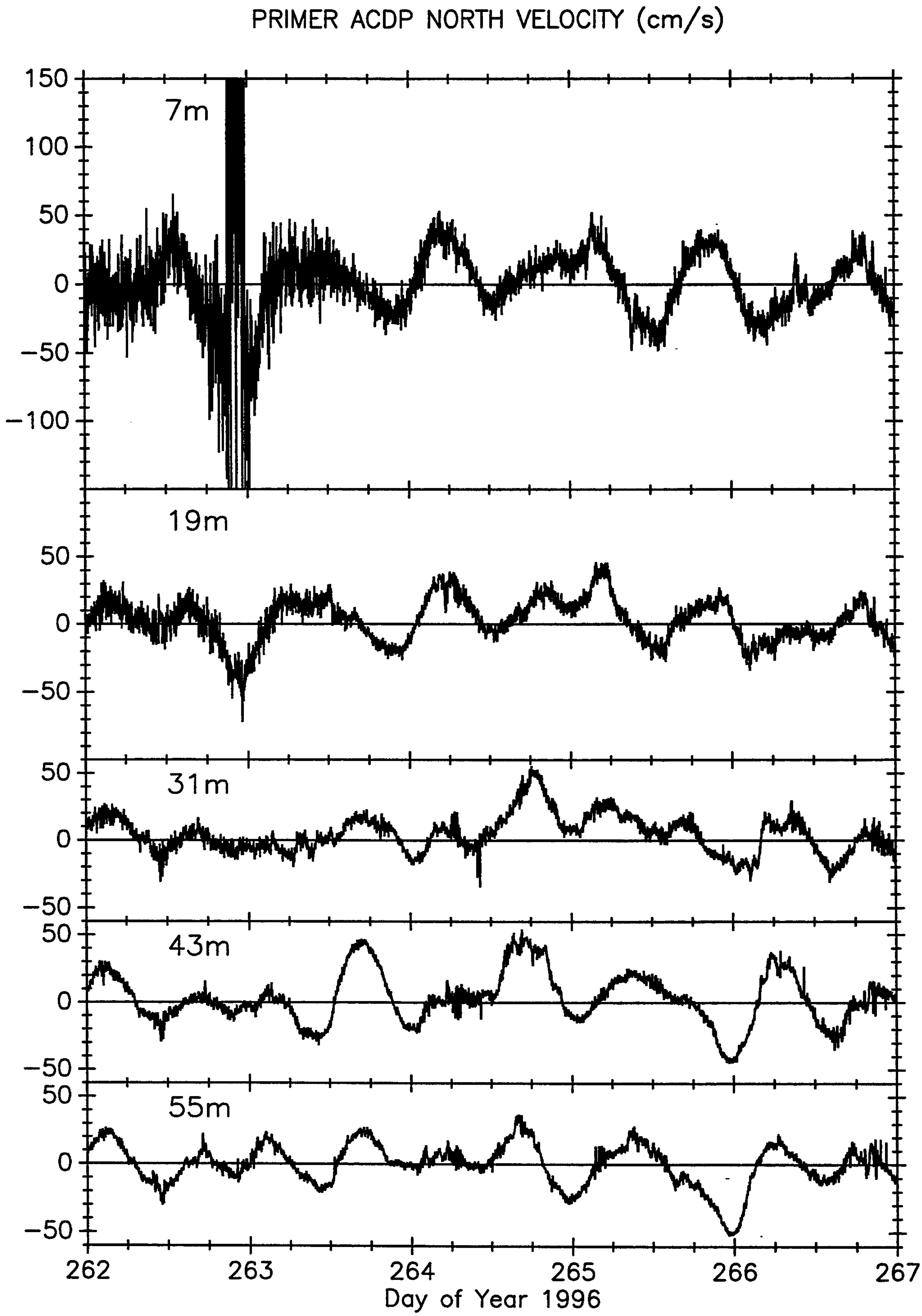

PRIMER ACDP NORTH VELOCITY (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
−50
−100
237
238
239
240
241
242
Day of Year 1996

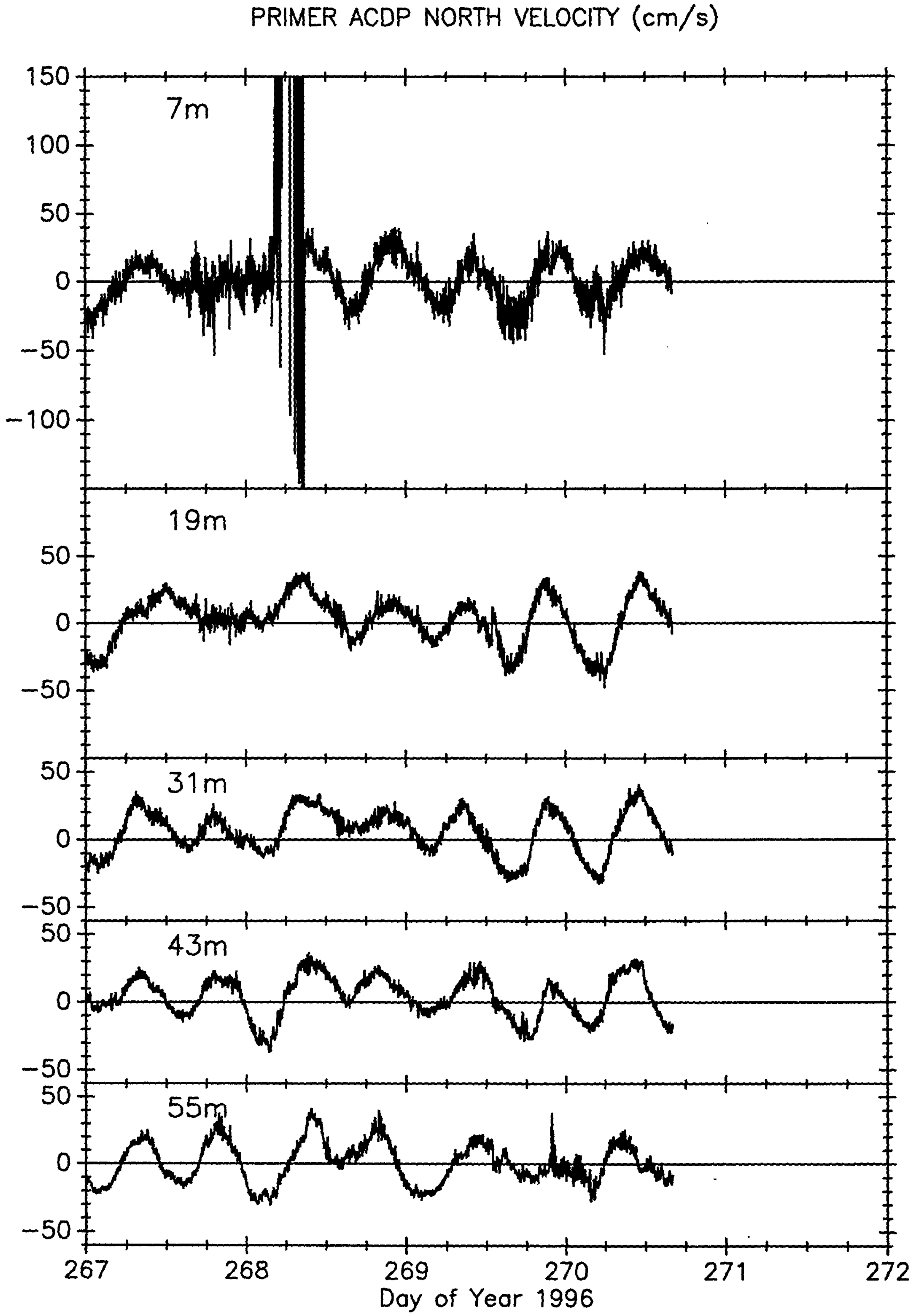

PRIMER ACDP NORTH VELOCITY (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
−50
−100
242
243
244
245
246
247
Day of Year 1996


PRIMER ACDP NORTH VELOCITY (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
−50
−100
247
248
249
250
251
252
Day of Year 1996


PRIMER ACDP NORTH VELOCITY (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
−50
−100
252
253
254
255
256
257
Day of Year 1996


PRIMER ACDP NORTH VELOCITY (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
−50
−100
257
258
259
260
261
262
Day of Year 1996


PRIMER ACDP NORTH VELOCITY (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
−50
−100
262
263
264
265
266
267
Day of Year 1996


PRIMER ACDP NORTH VELOCITY (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
−50
−100
267
268
269
270
271
272
Day of Year 1996

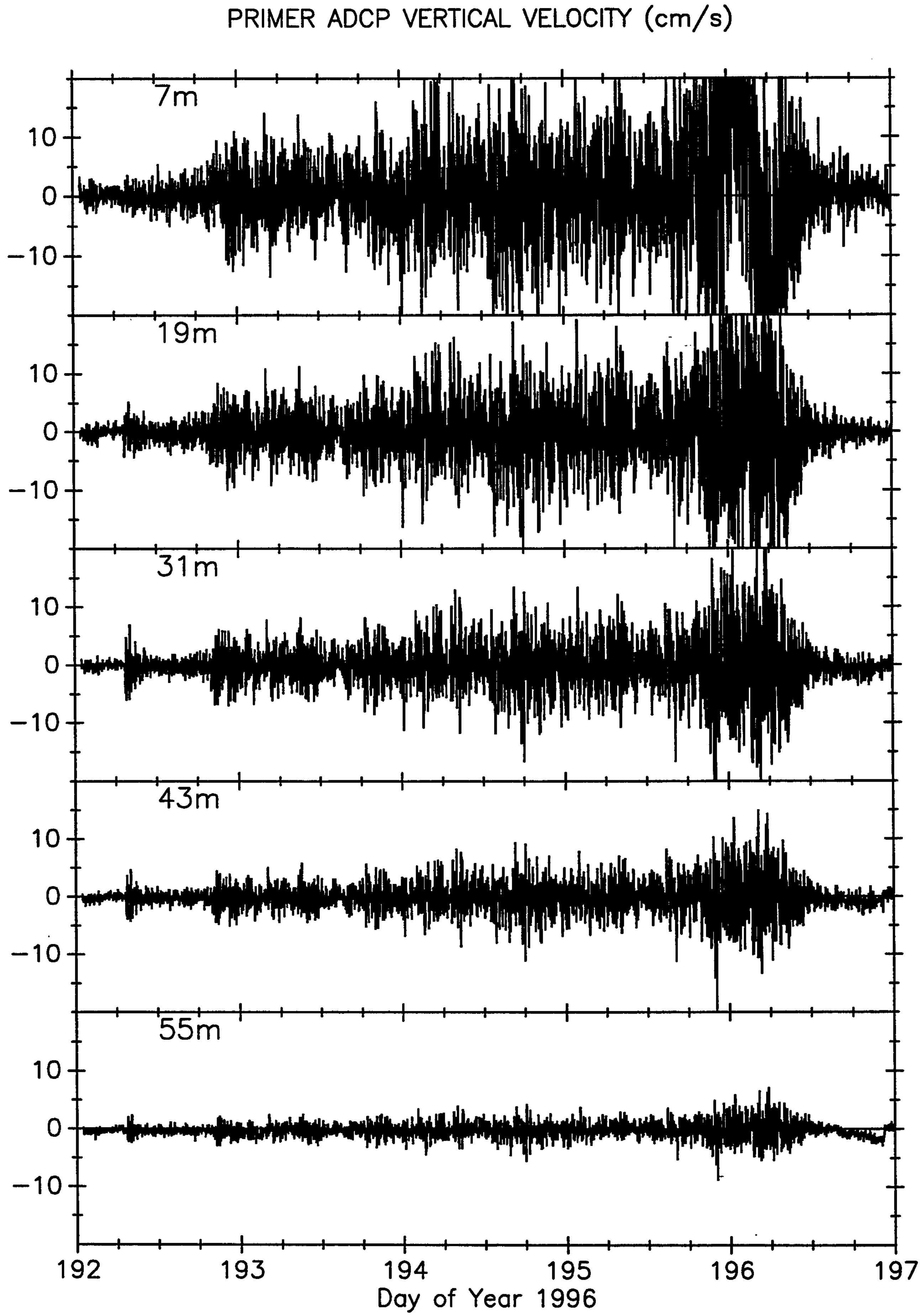
VELOCITY (ADCP) Time Series

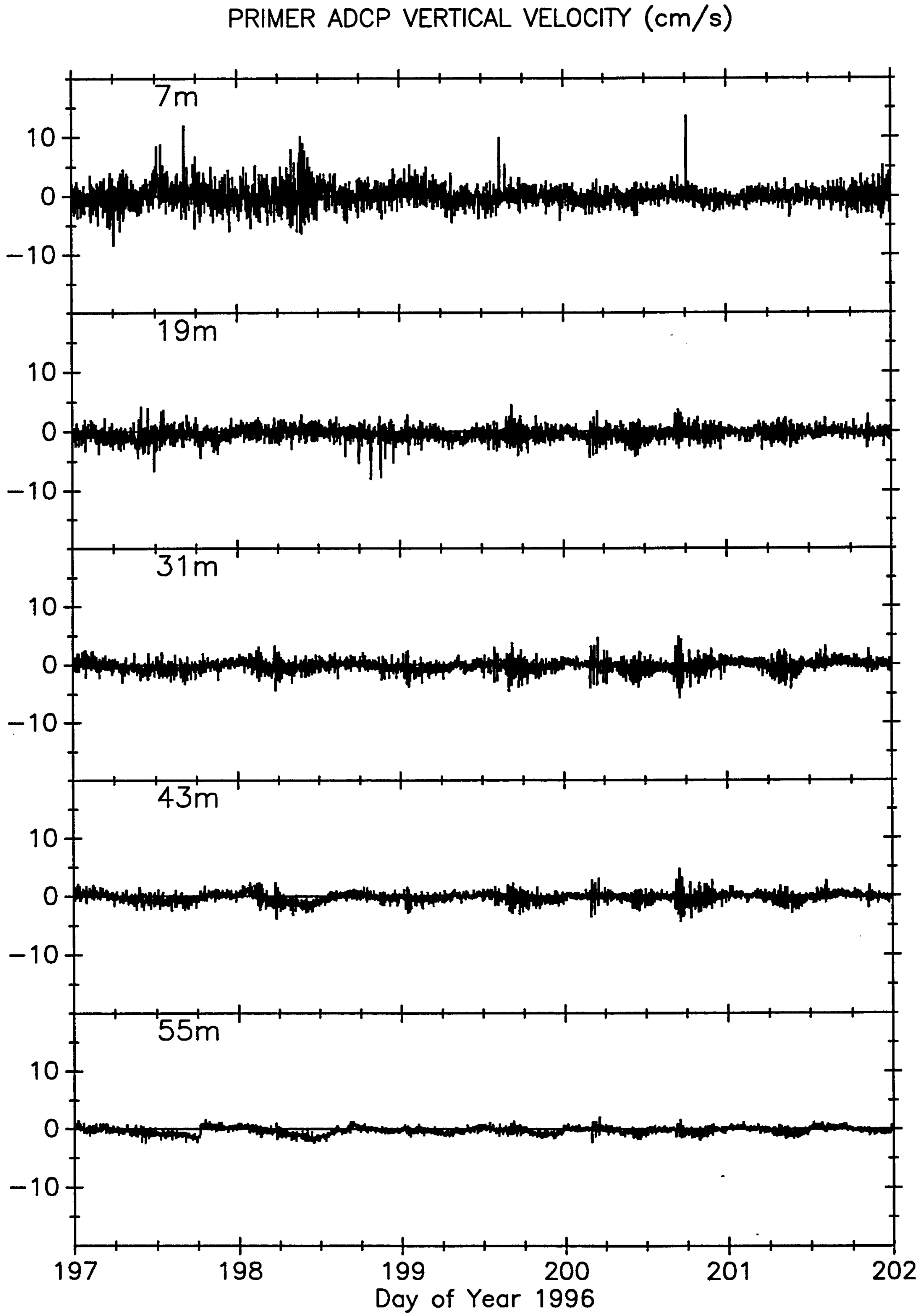
Vertical Component

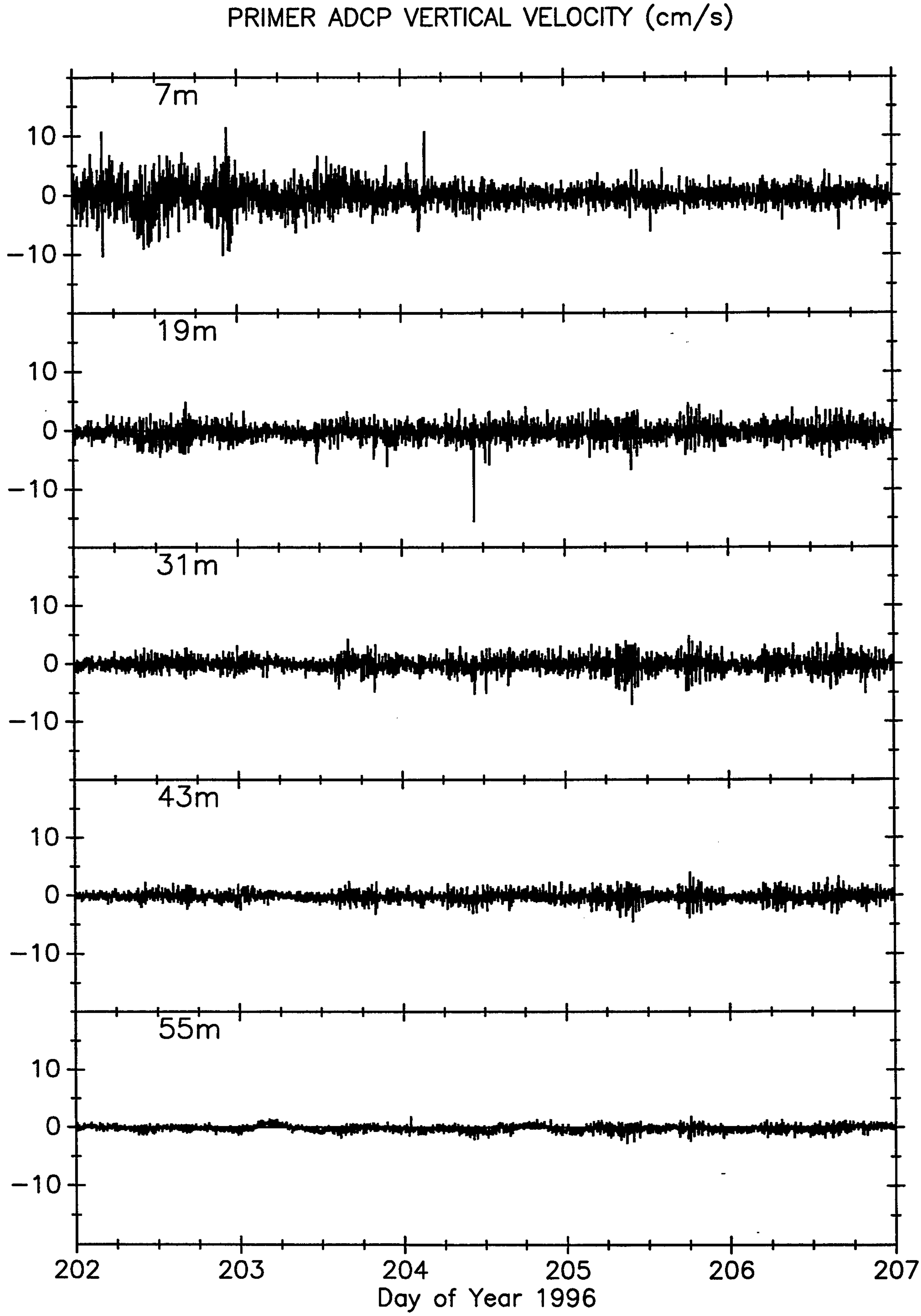
Main Mooring

Unfiltered

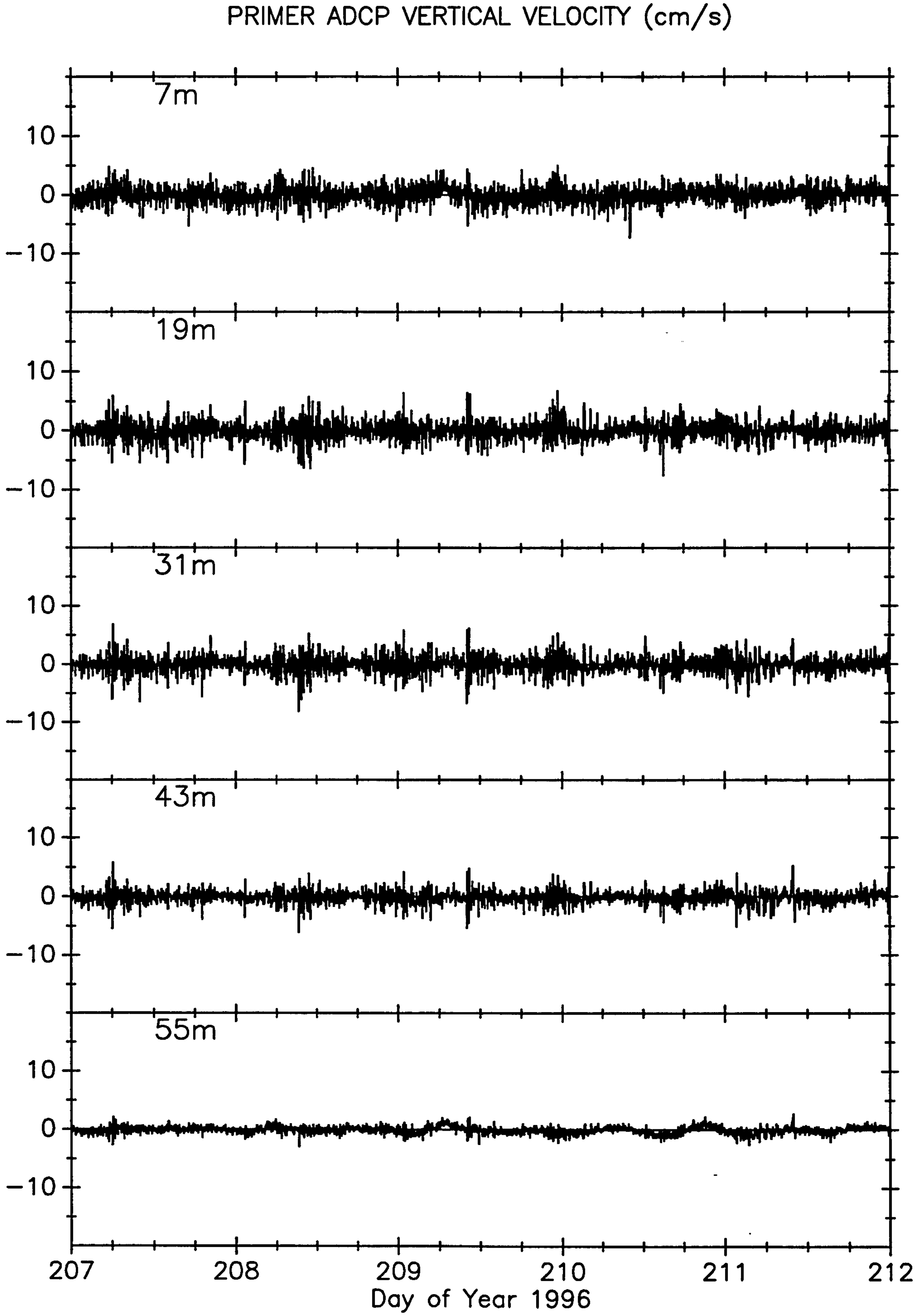
ADCP vertical component of velocity from 4-meter bins centered at 7 m, 19 m, 31 m, 43 m, and 55 m on the Main mooring. Velocity components are not filtered. The ADCP generates a vector-averaged velocity sample at two minute intervals.

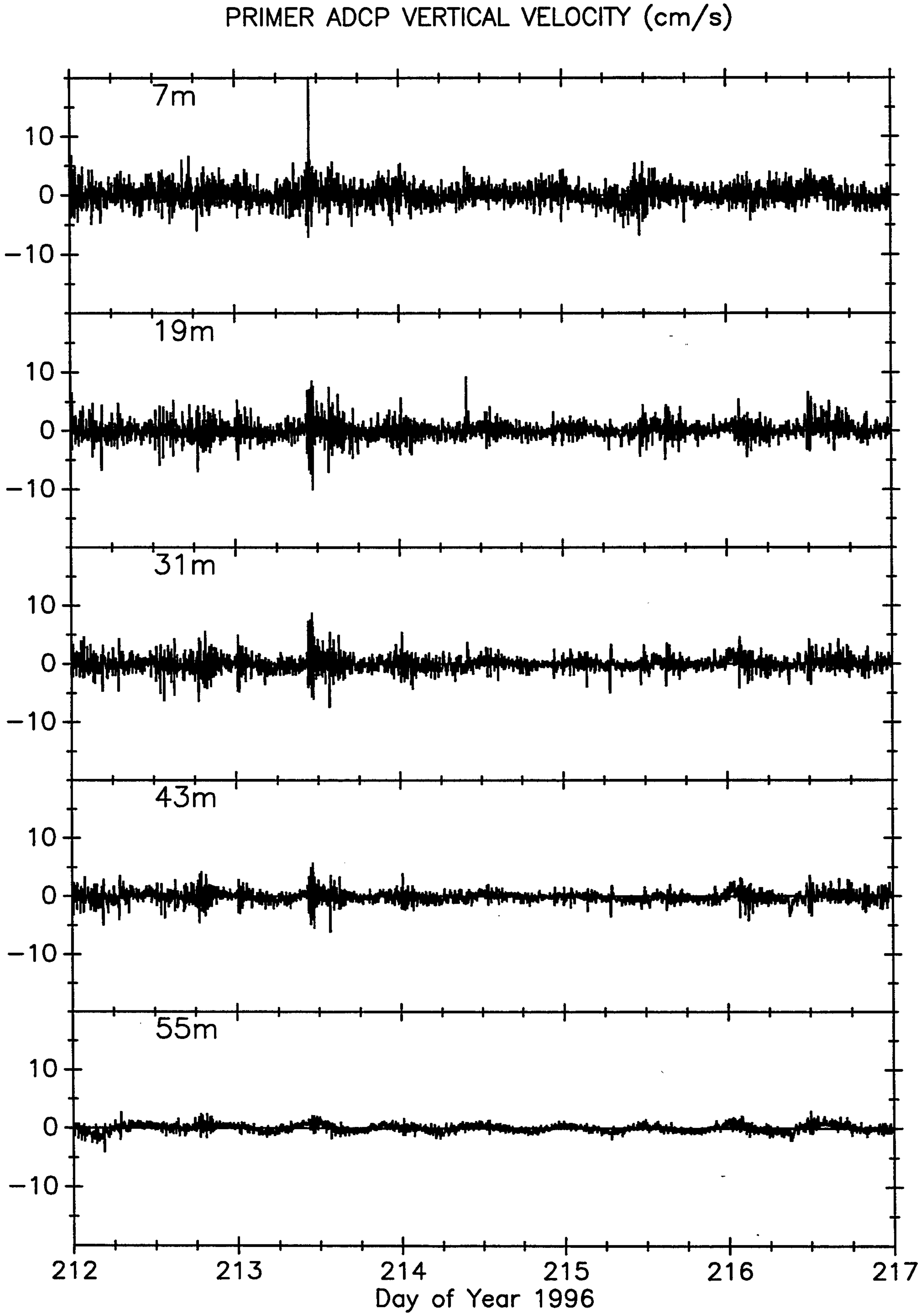

PRIMER ADCP VERTICAL VELOCITY (cm/s)
7m
19m
31m
43m
55m
10
0
−10
192
193
194
195
196
197
Day of Year 1996

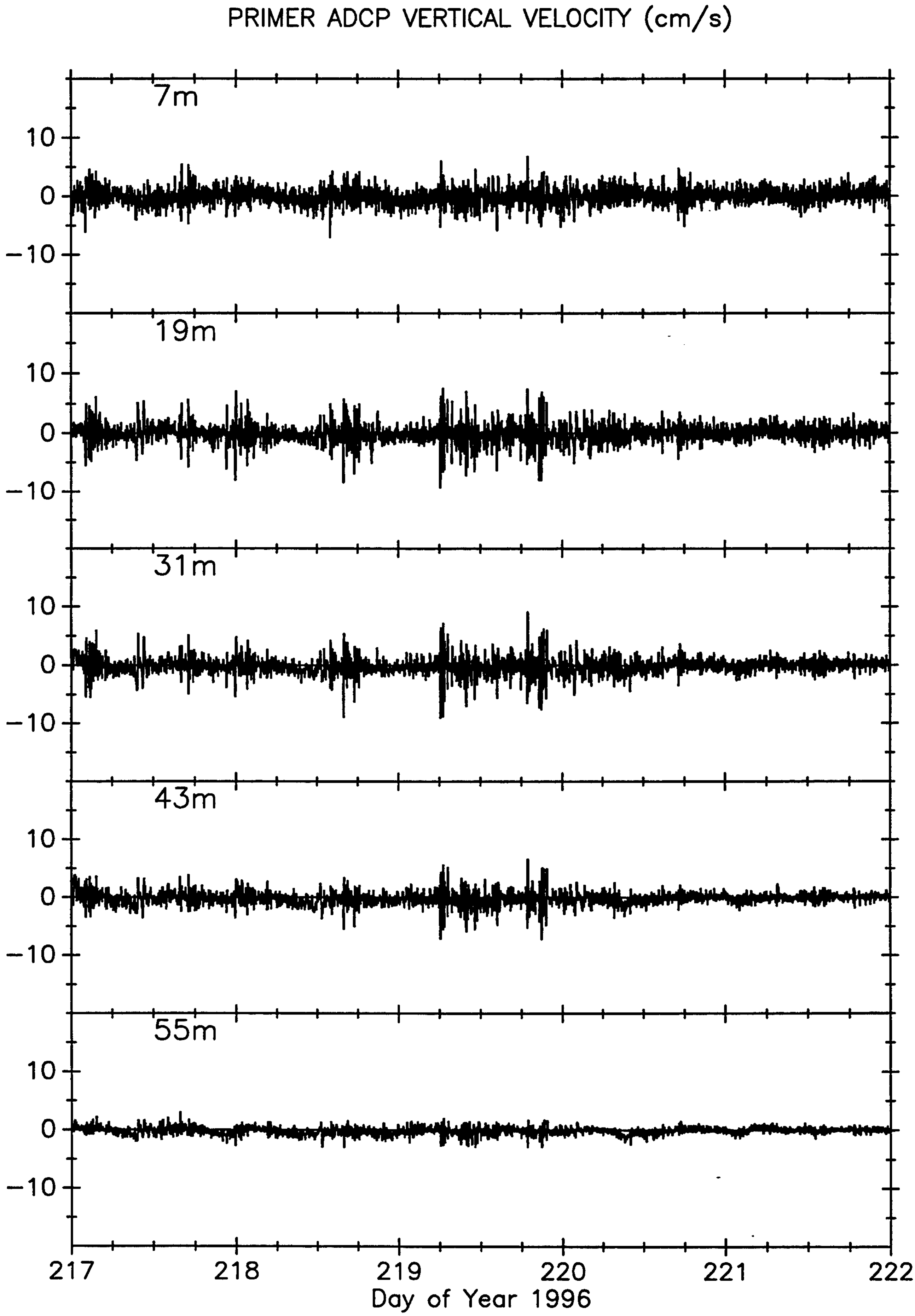

PRIMER ADCP VERTICAL VELOCITY (cm/s)
7m
19m
31m
43m
55m
10
0
−10
197
198
199
200
201
202
Day of Year 1996

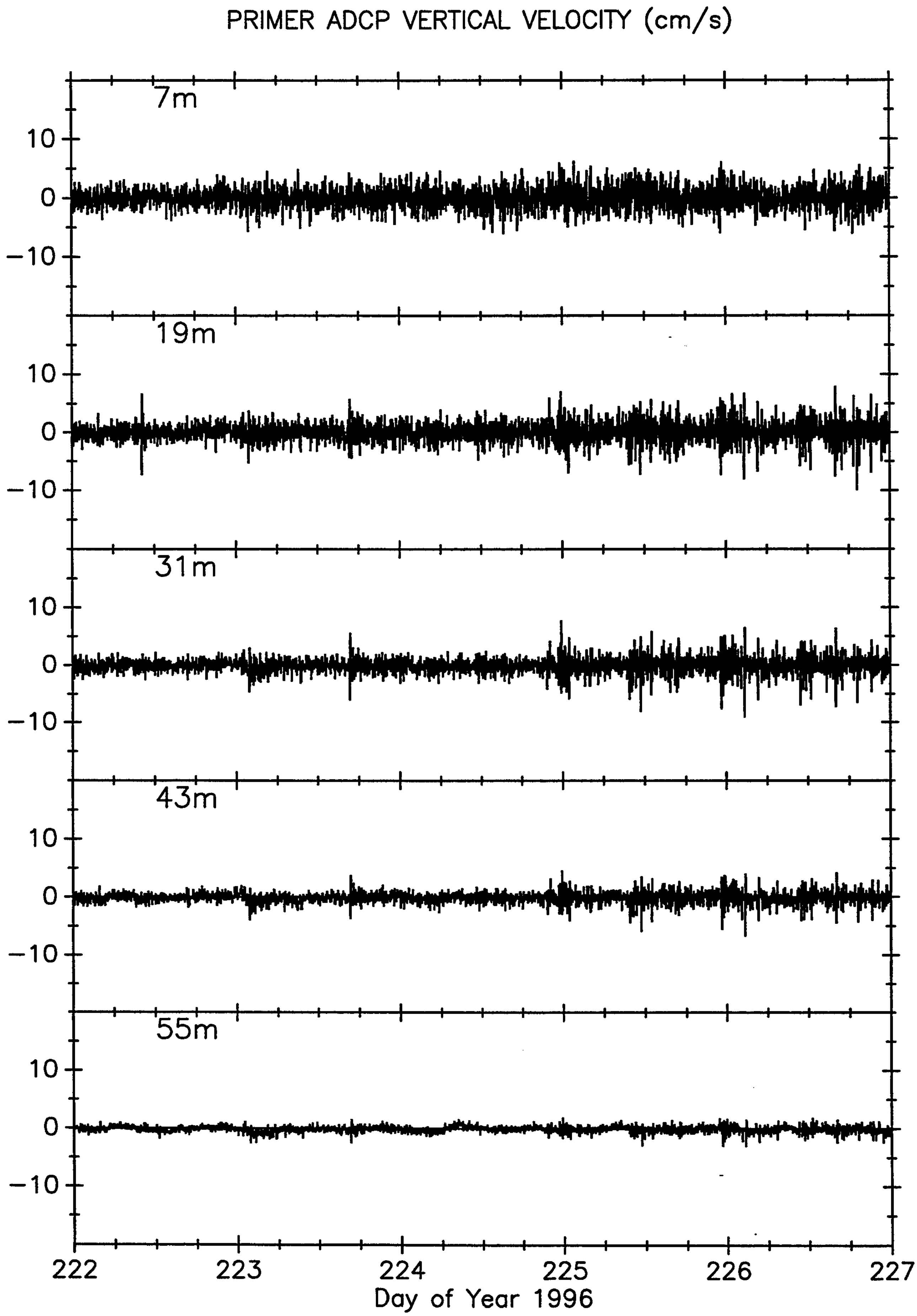


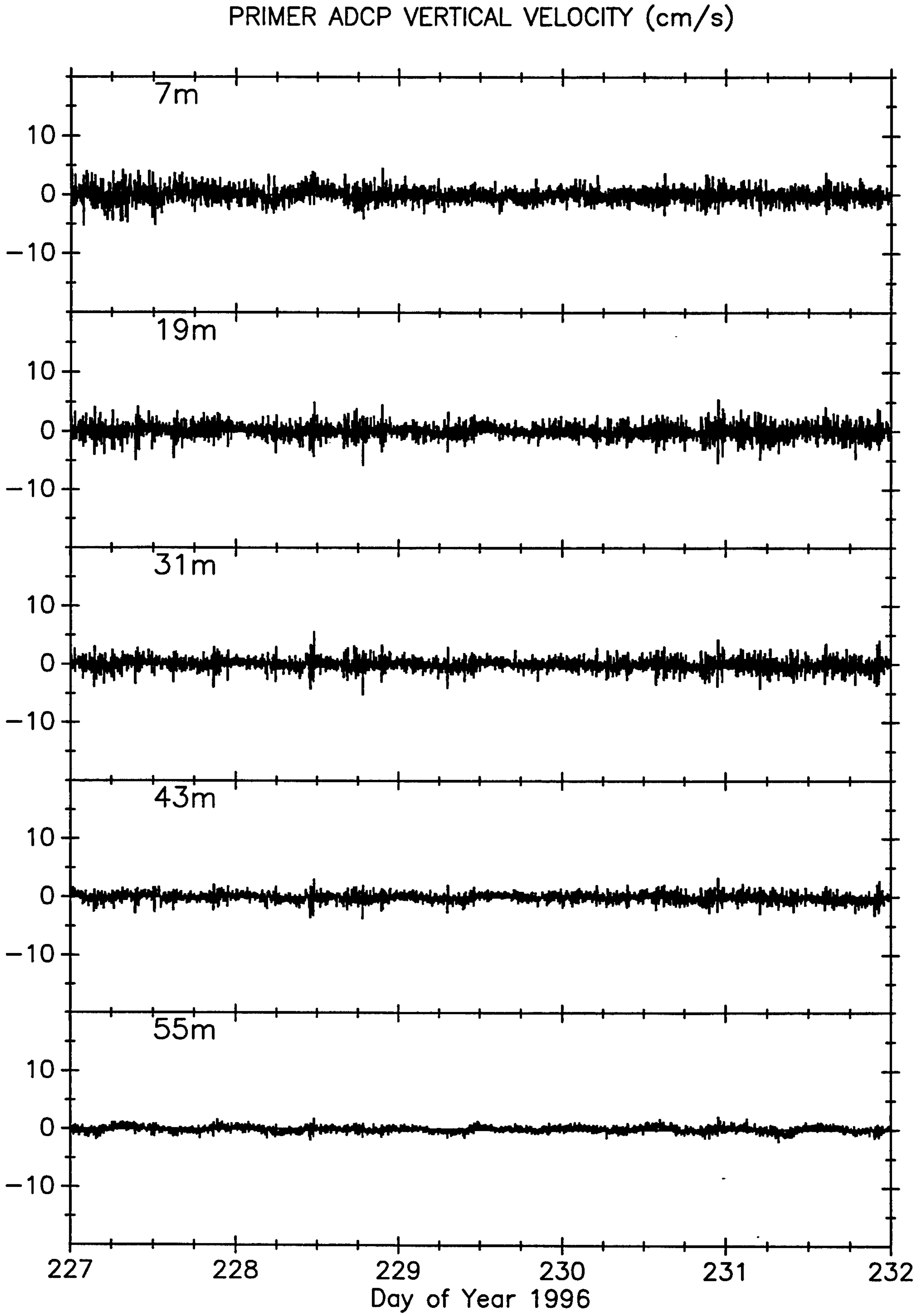
PRIMER ADCP VERTICAL VELOCITY (cm/s)
7m
19m
31m
43m
55m
10
0
−10
202
203
204
205
206
207
Day of Year 1996


PRIMER ADCP VERTICAL VELOCITY (cm/s)
7m
19m
31m
43m
55m
10
0
−10
207
208
209
210
211
212
Day of Year 1996

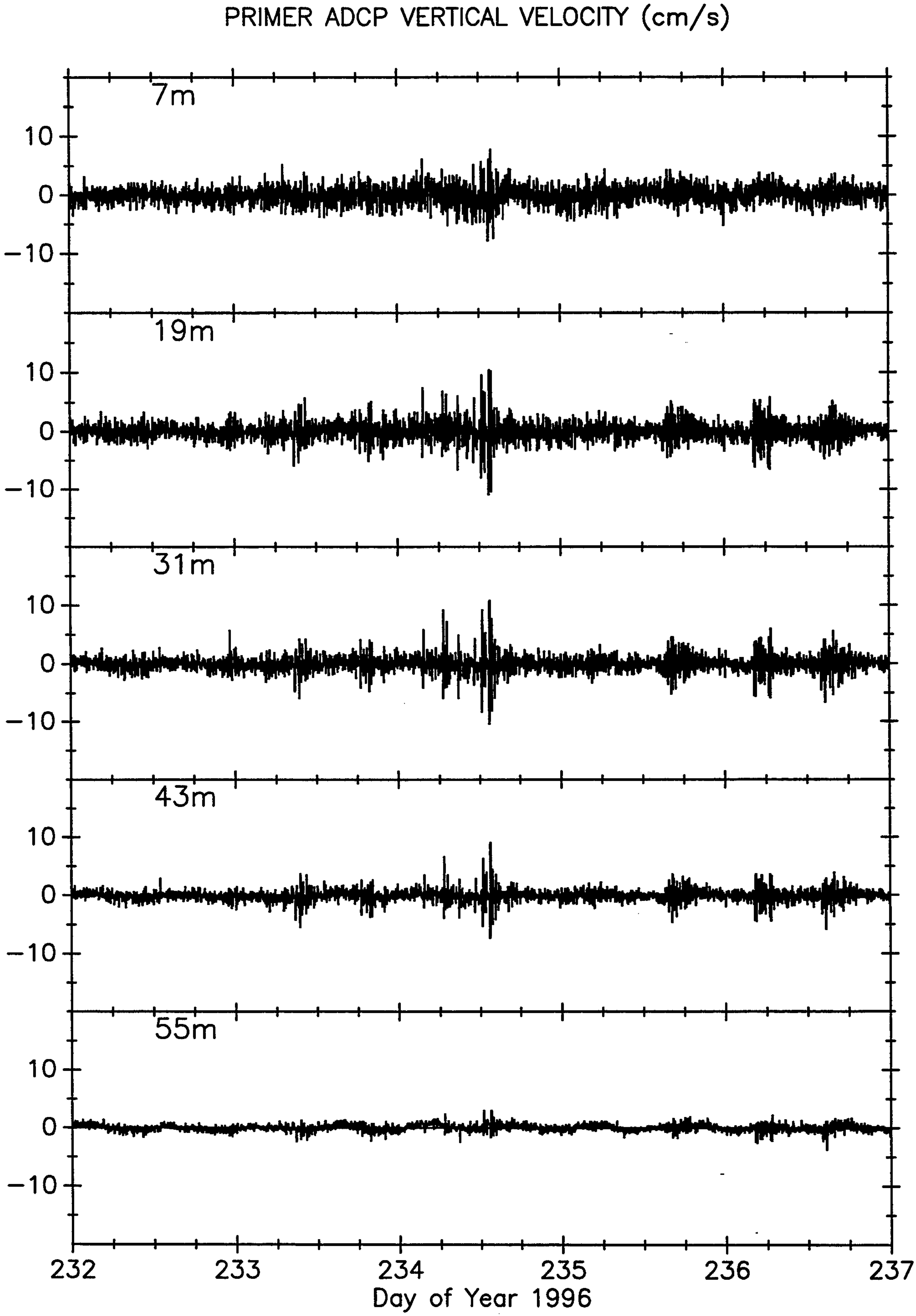

PRIMER ADCP VERTICAL VELOCITY (cm/s)
7m
19m
31m
43m
55m
10
0
−10
212
213
214
215
216
217
Day of Year 1996

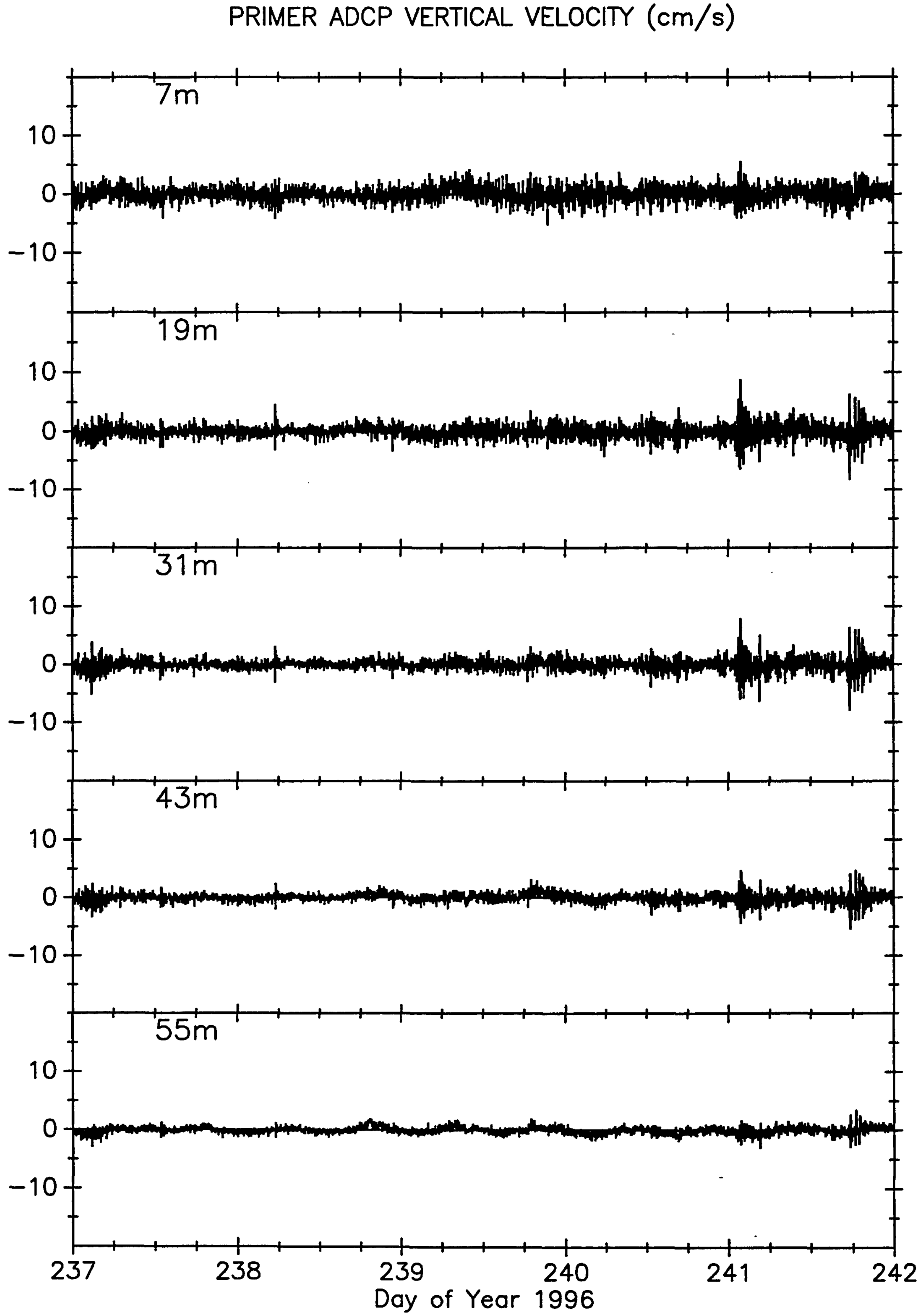

PRIMER ADCP VERTICAL VELOCITY (cm/s)
7m
19m
31m
43m
55m
10
0
−10
217
218
219
220
221
222
Day of Year 1996

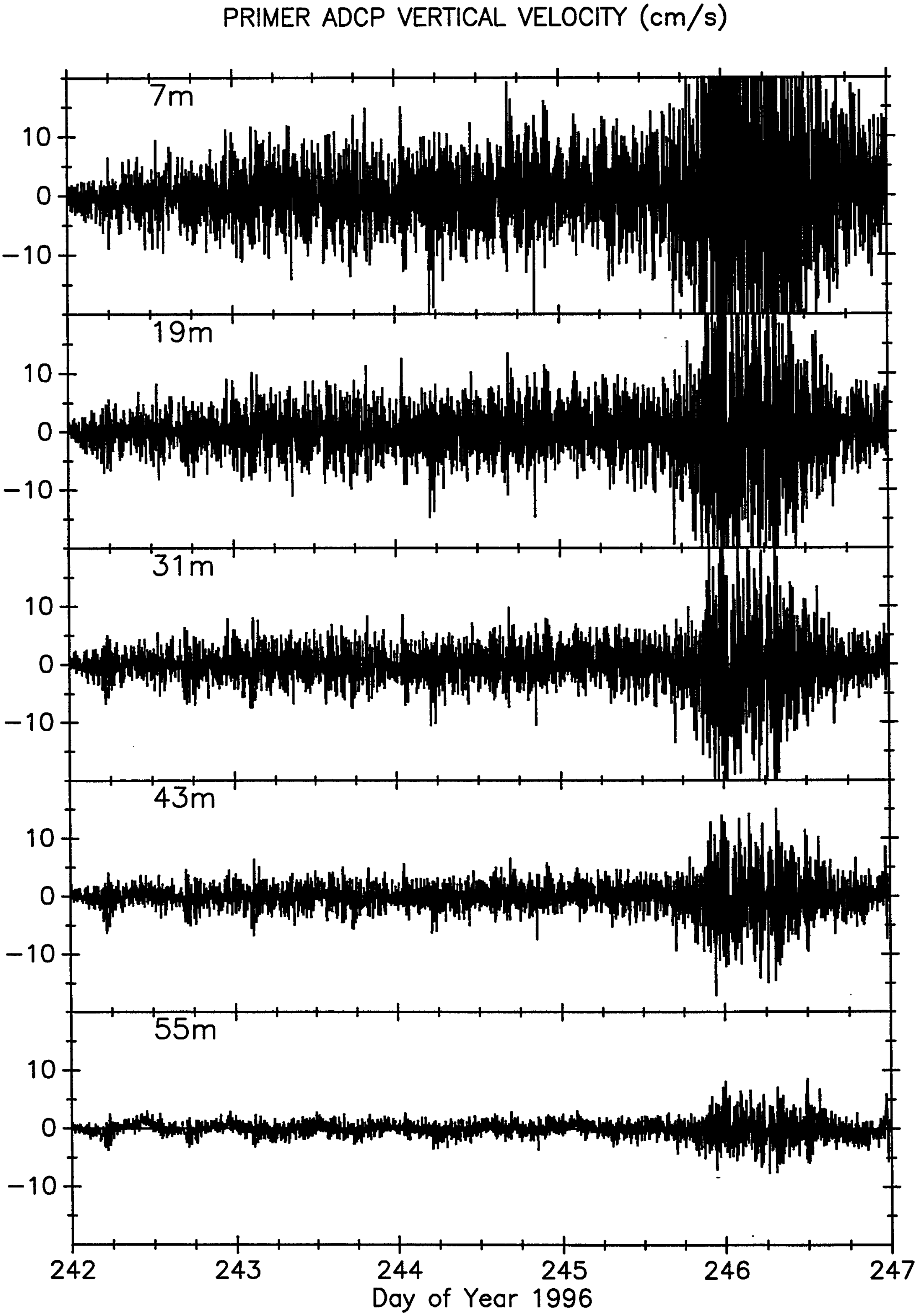

PRIMER ADCP VERTICAL VELOCITY (cm/s)
7m
19m
31m
43m
55m
10
0
−10
222
223
224
225
226
227
Day of Year 1996

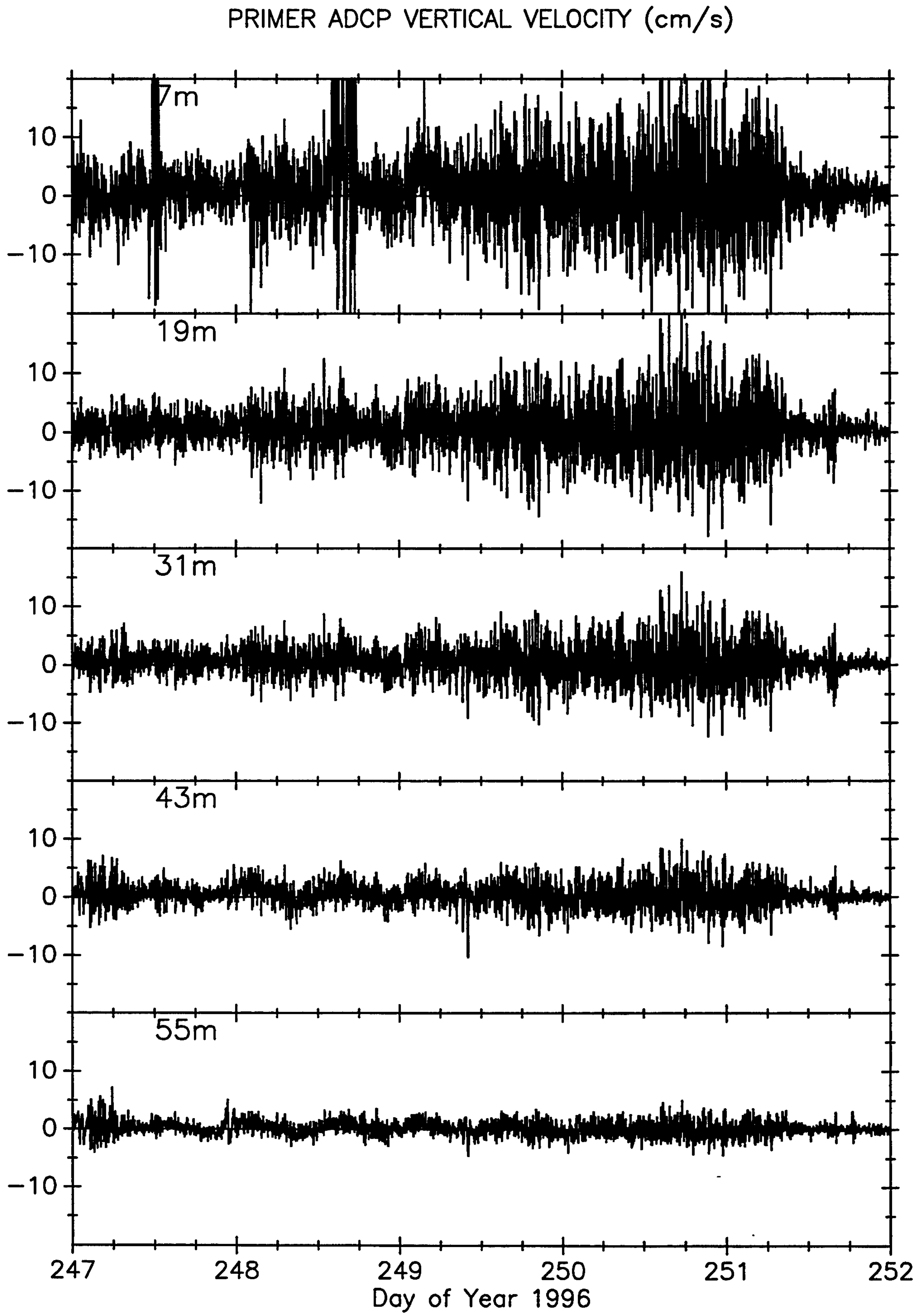


PRIMER ADCP VERTICAL VELOCITY (cm/s)
7m
19m
31m
43m
55m
10
0
−10
227
228
229
230
231
232
Day of Year 1996

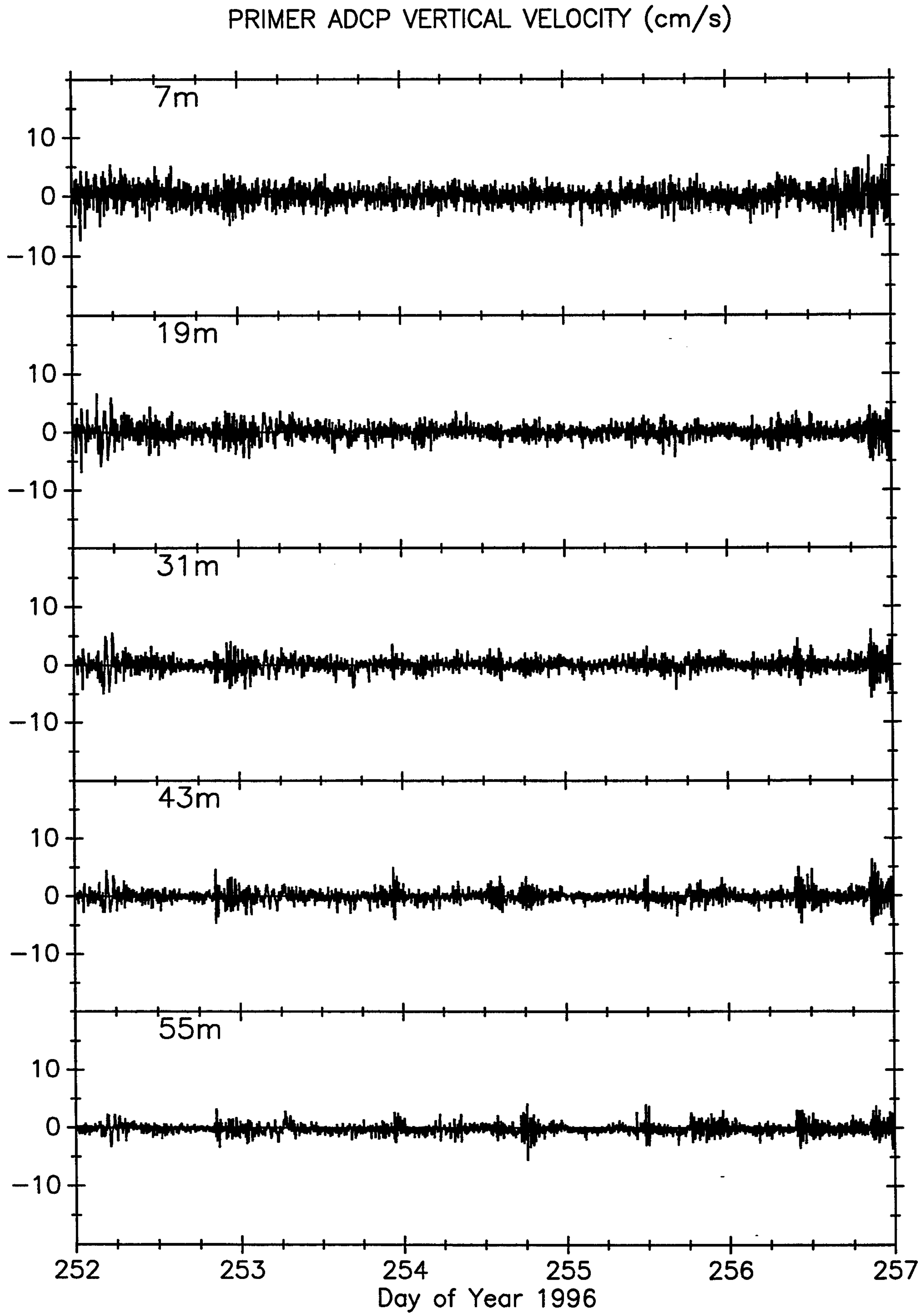

PRIMER ADCP VERTICAL VELOCITY (cm/s)
7m
19m
31m
43m
55m
10
0
−10
232
233
234
235
236
237
Day of Year 1996

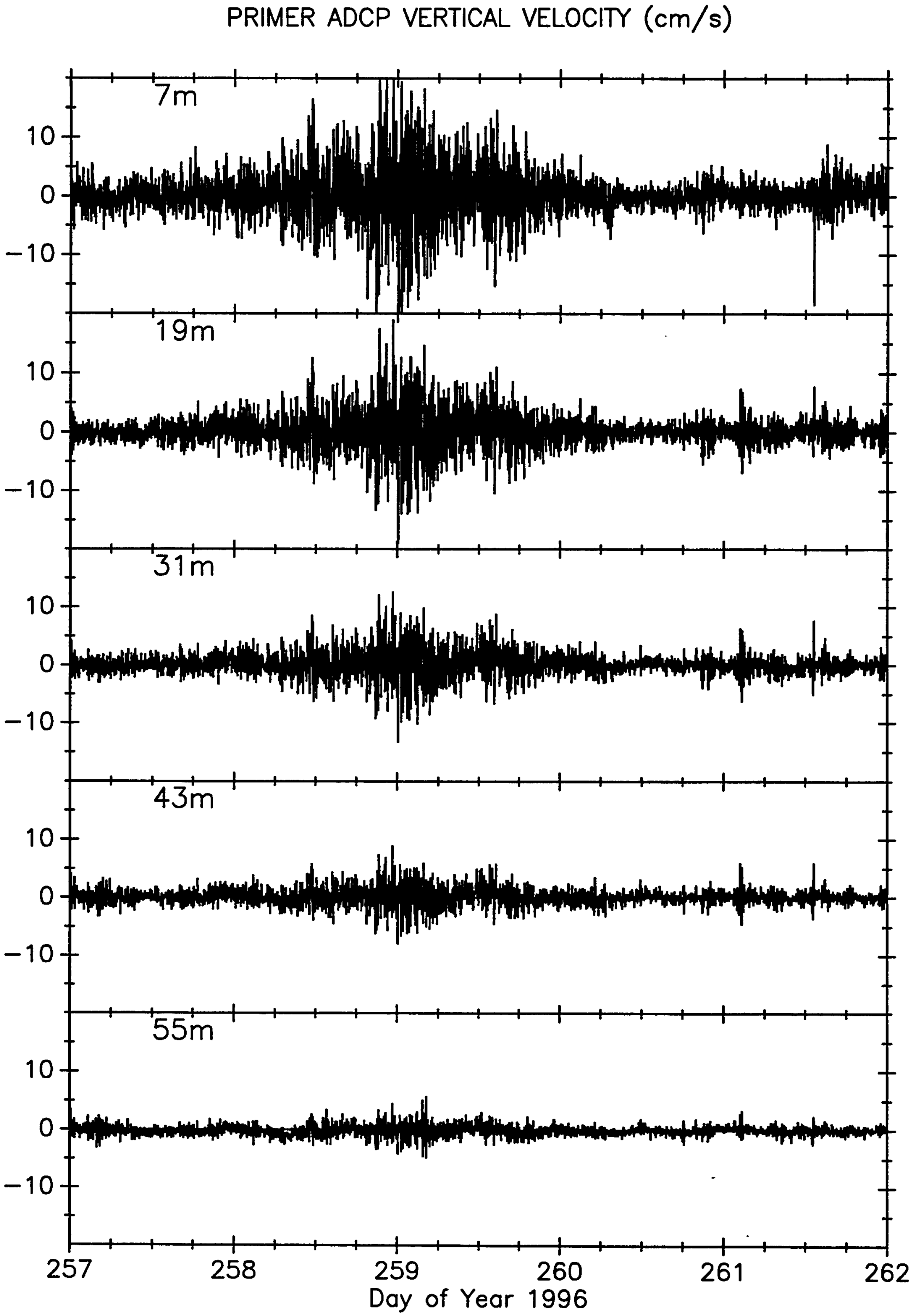

PRIMER ADCP VERTICAL VELOCITY (cm/s)
7m
19m
31m
43m
55m
10
0
−10
237
238
239
240
241
242
Day of Year 1996


PRIMER ADCP VERTICAL VELOCITY (cm/s)
7m
19m
31m
43m
55m
10
0
−10
242
243
244
245
246
247
Day of Year 1996

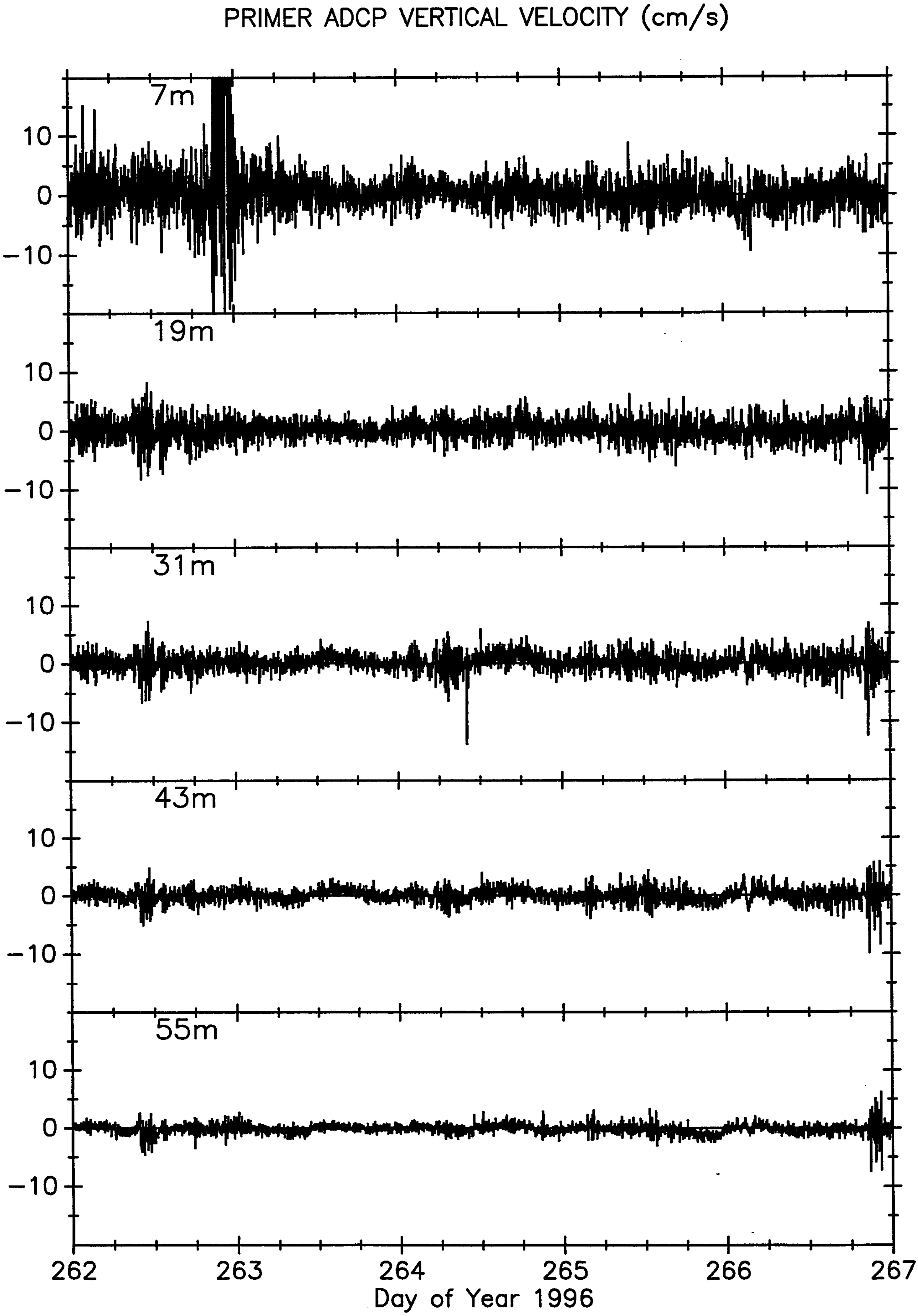


PRIMER ADCP VERTICAL VELOCITY (cm/s)
7m
19m
31m
43m
55m
10
0
−10
247
248
249
250
251
252
Day of Year 1996

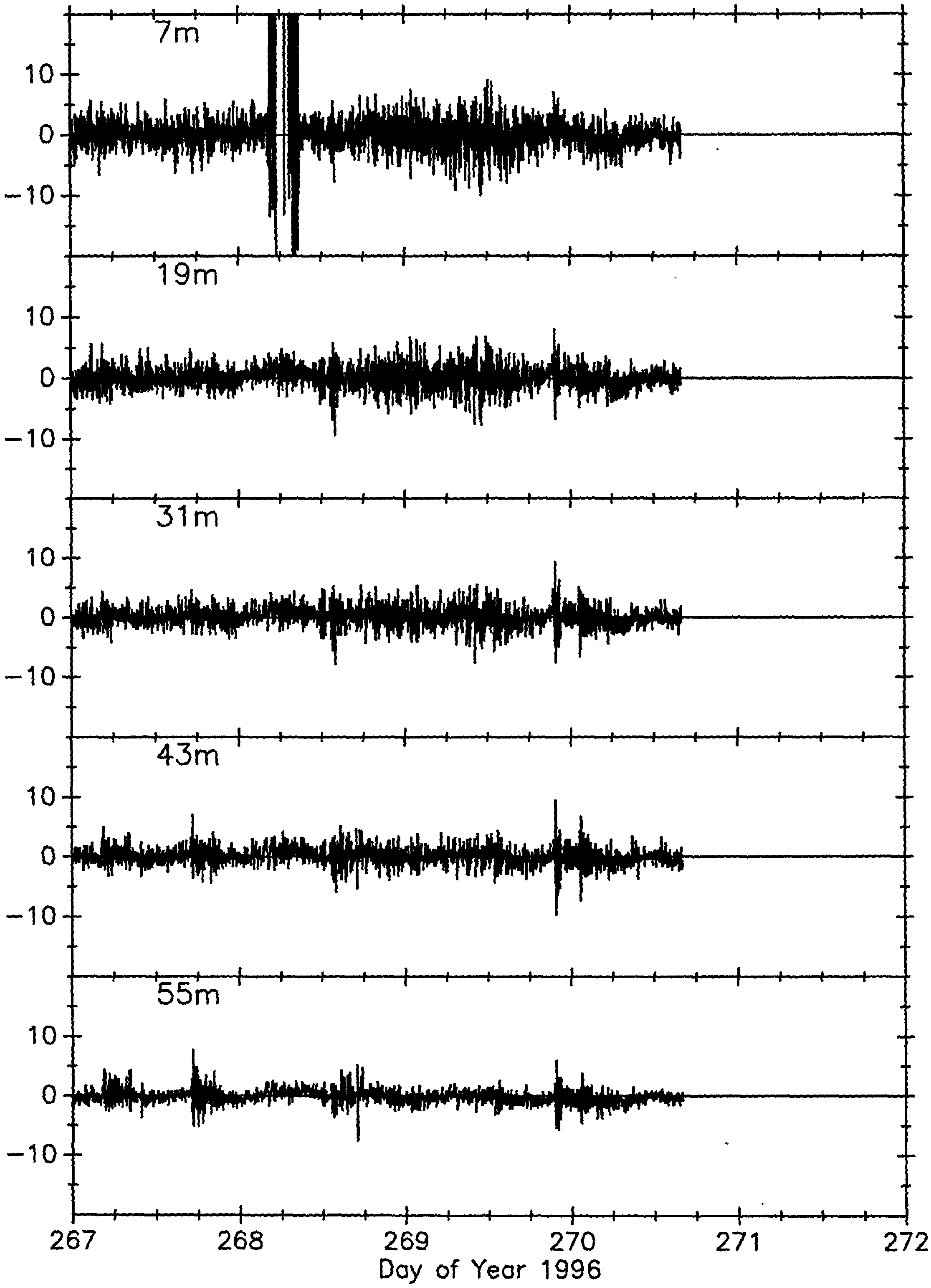

PRIMER ADCP VERTICAL VELOCITY (cm/s)
7m
19m
31m
43m
55m
10
0
−10
252
253
254
255
256
257
Day of Year 1996



PRIMER ADCP VERTICAL VELOCITY (cm/s)
7m
19m
31m
43m
55m
10
0
−10
257
258
259
260
261
262
Day of Year 1996


PRIMER ADCP VERTICAL VELOCITY (cm/s)
7m
19m
31m
43m
55m
10
0
−10
262
263
264
265
266
267
Day of Year 1996

PRIMER ADCP VERTICAL VELOCITY (cm/s)



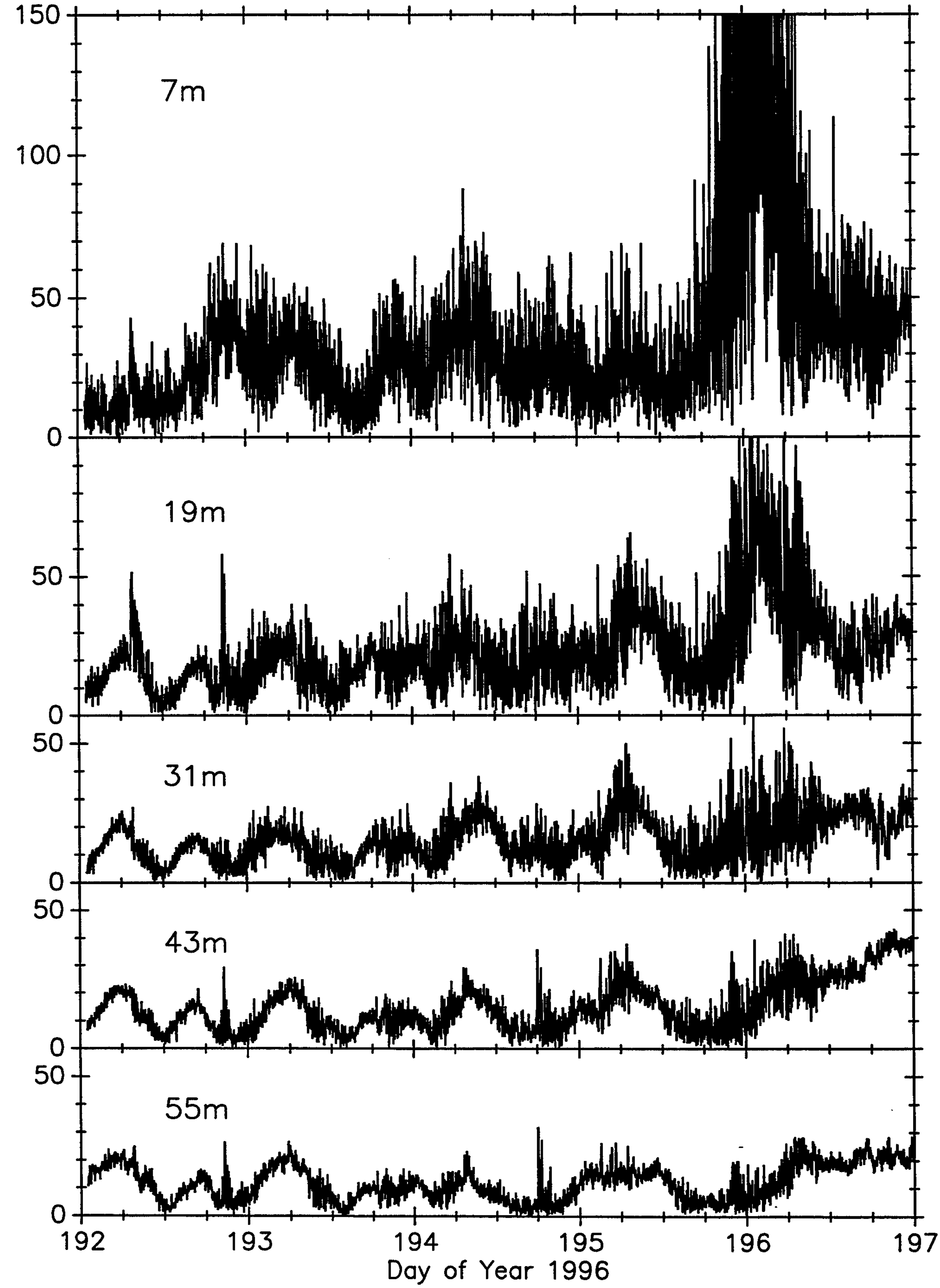
SPEED (ADCP) Time Series

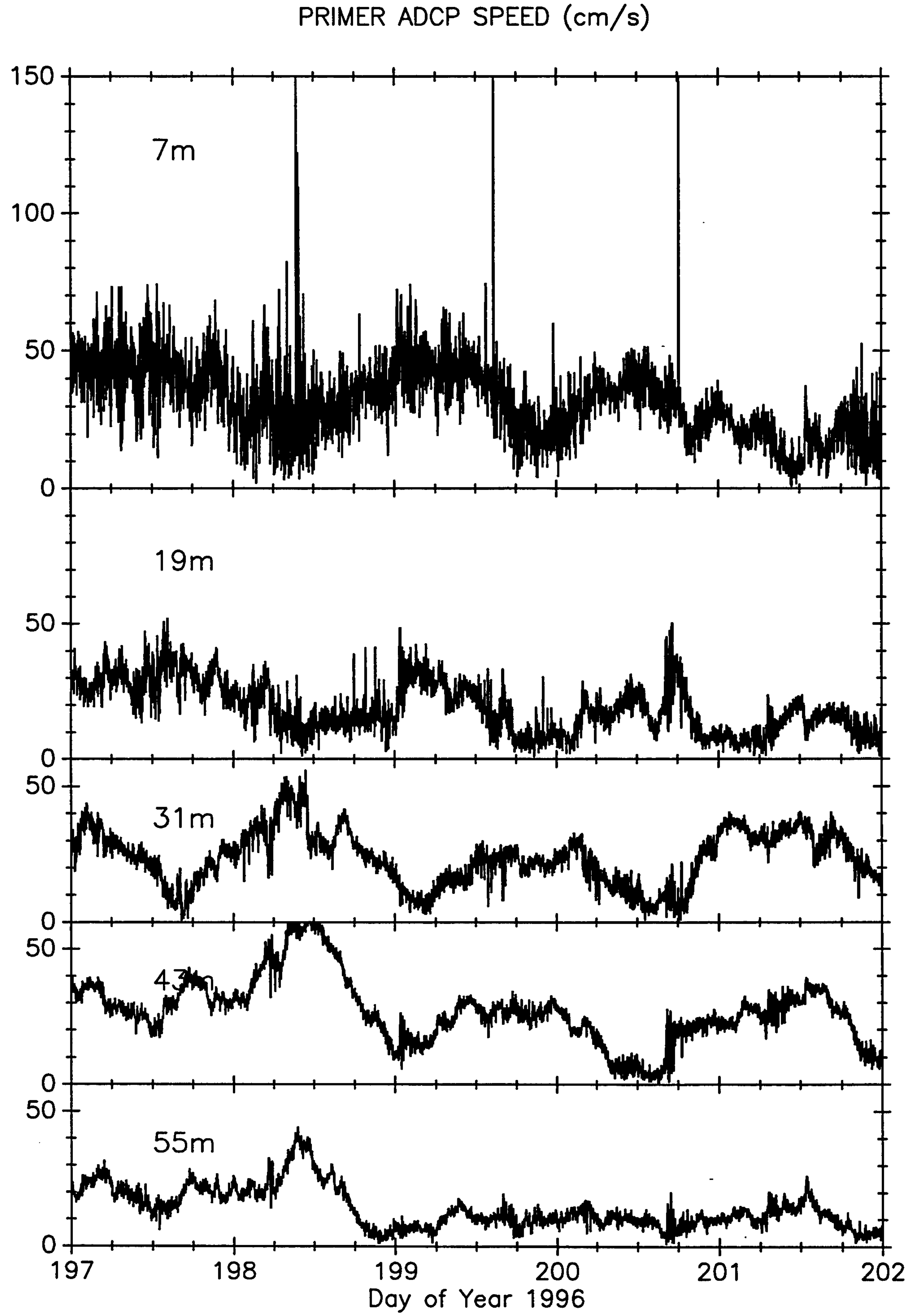
Main Mooring

Unfiltered

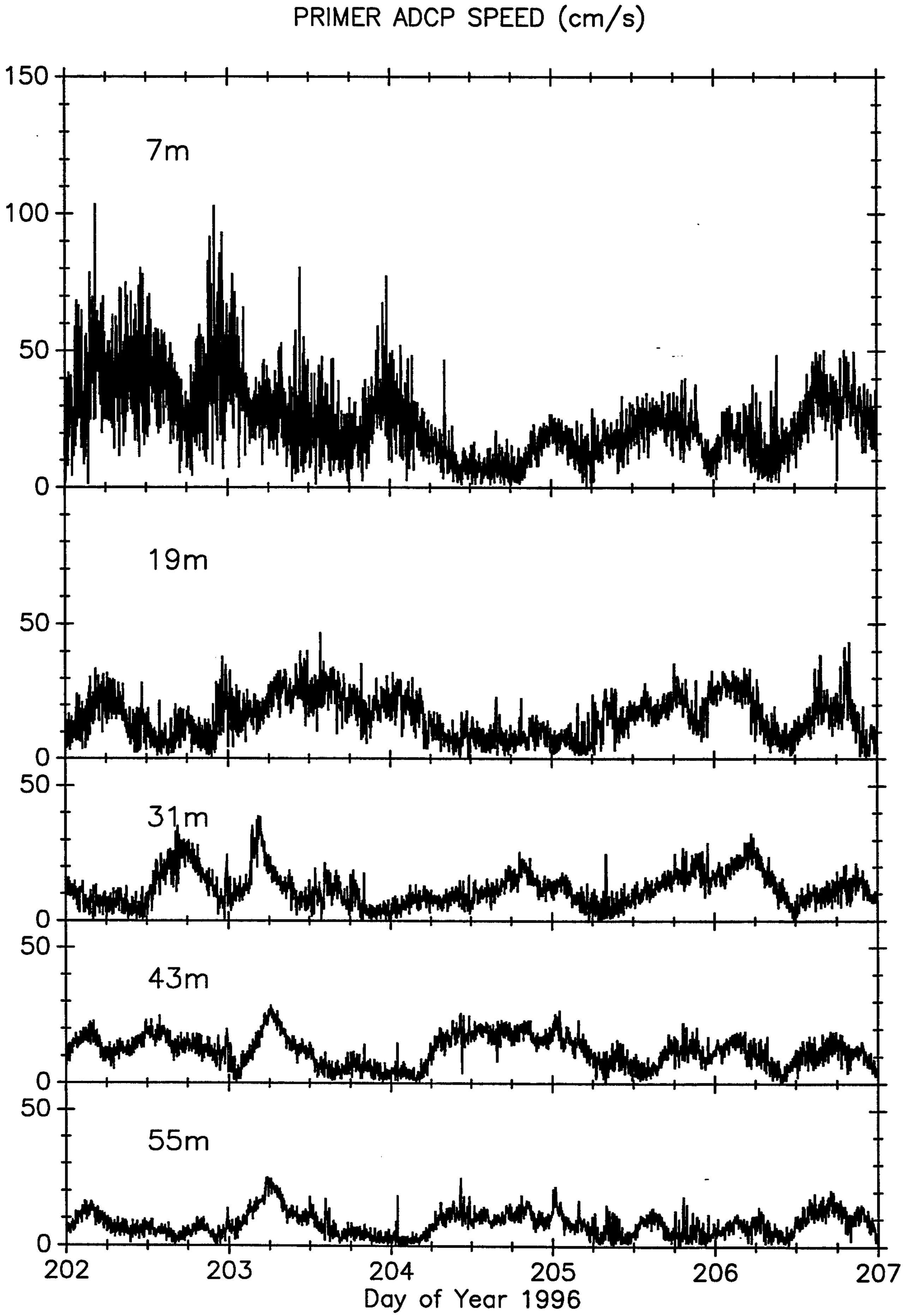
ADCP speed (magnitude of vector velocity) from 4-meter bins centered at 7 m, 19 m, 31 m, 43 m, and 55 m on the Main mooring. Velocity components are not filtered. The ADCP generates a vector-averaged velocity sample at two minute intervals.

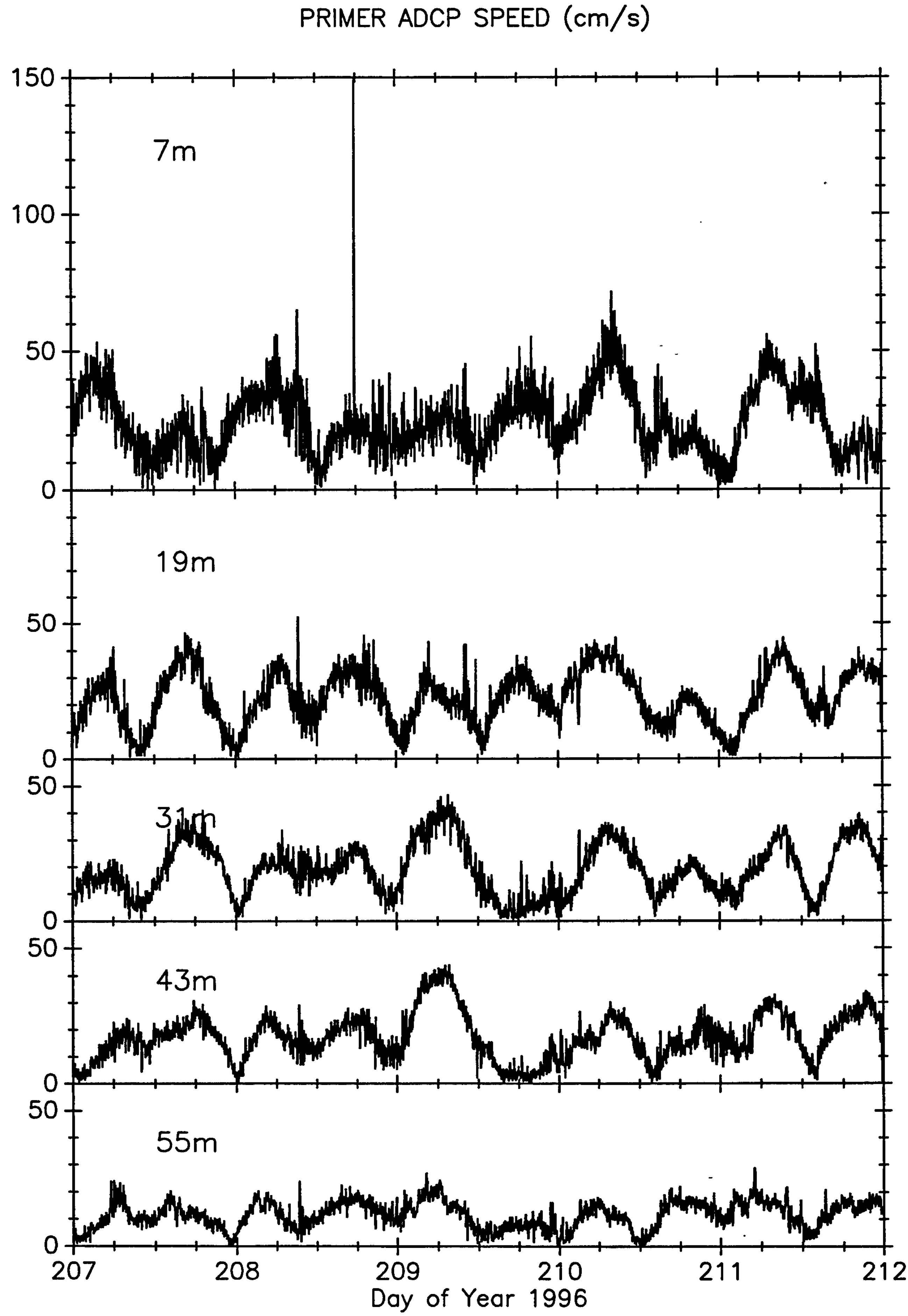
PRIMER ADCP SPEED (cm/s)





PRIMER ADCP SPEED (cm/s)
150
100
50
0
7m
19m
31m
43m
55m
197
198
199
200
201
202
Day of Year 1996


PRIMER ADCP SPEED (cm/s)
150
100
50
0
7m
19m
31m
43m
55m
202
203
204
205
206
207
Day of Year 1996


PRIMER ADCP SPEED (cm/s)
150
100
50
0
7m
19m
50
0
50
31m
0
50
43m
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50
55m
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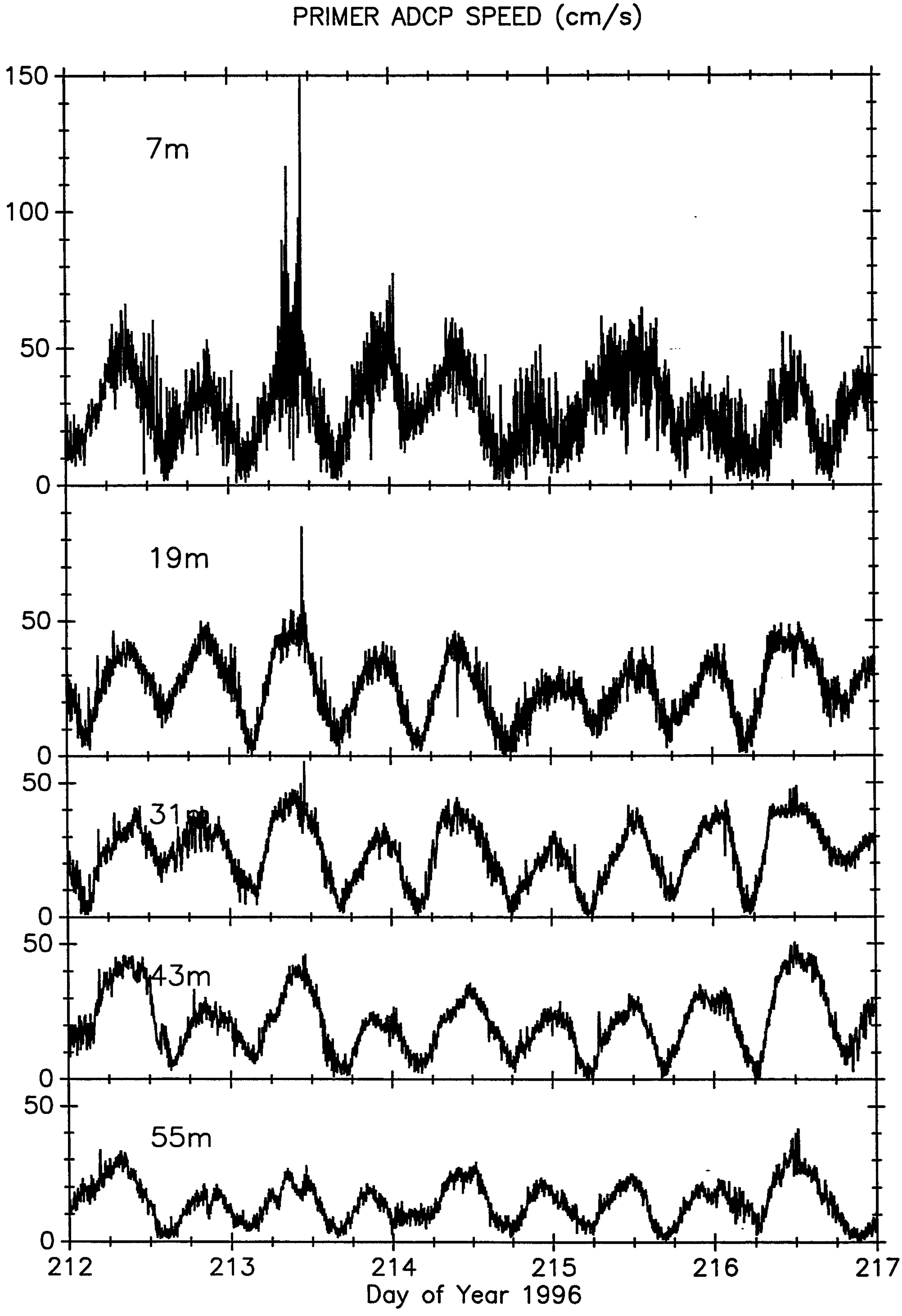
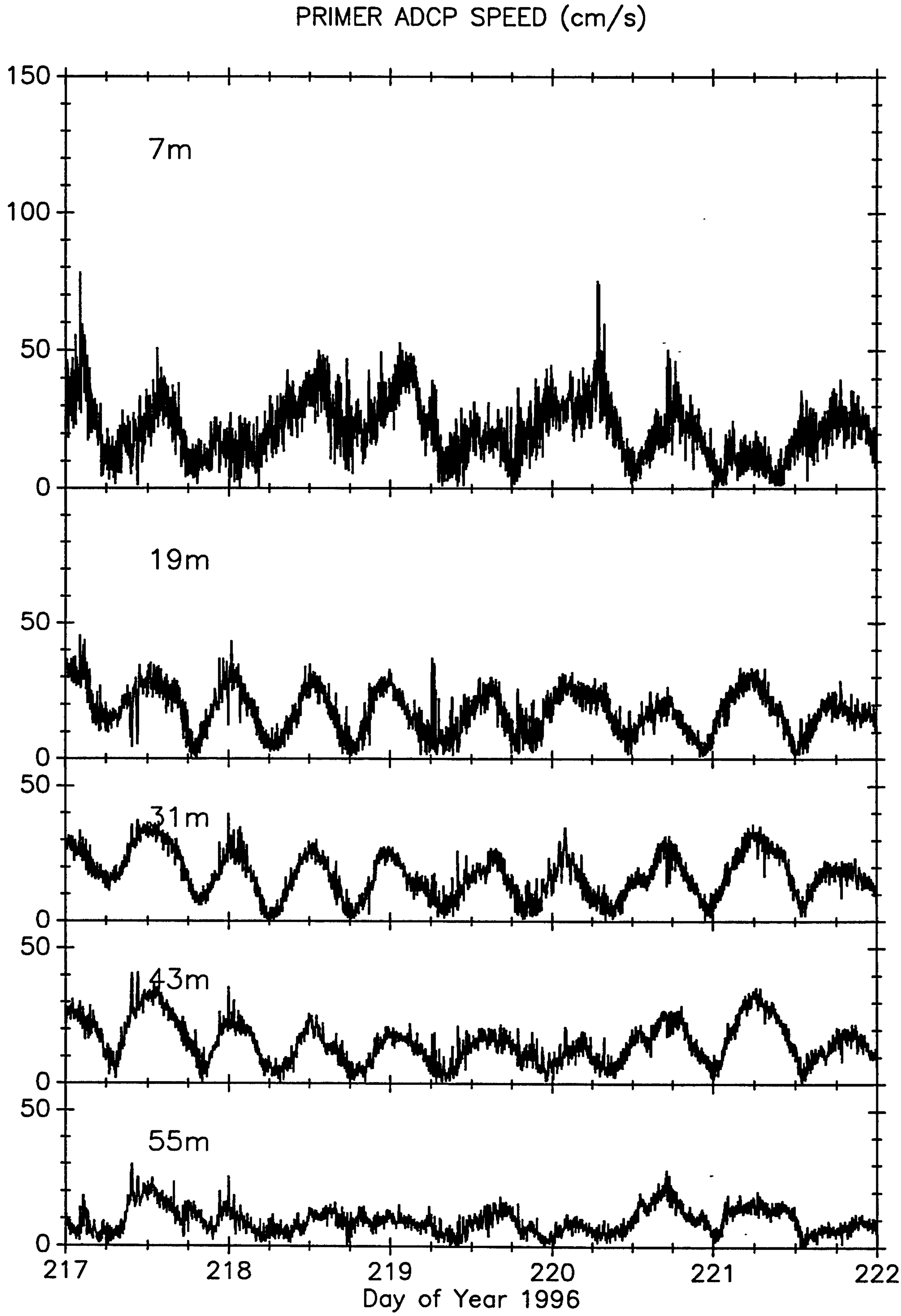
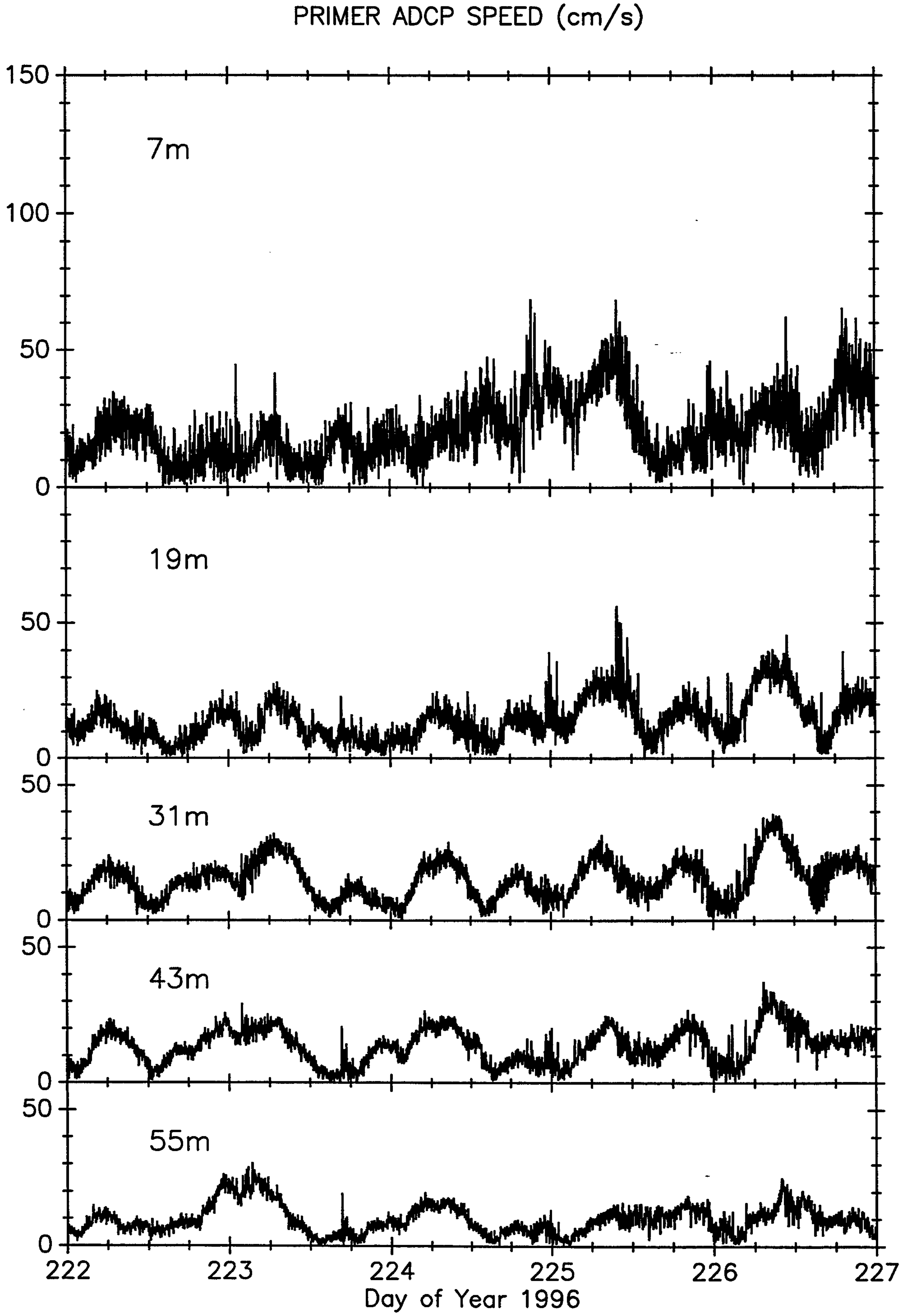
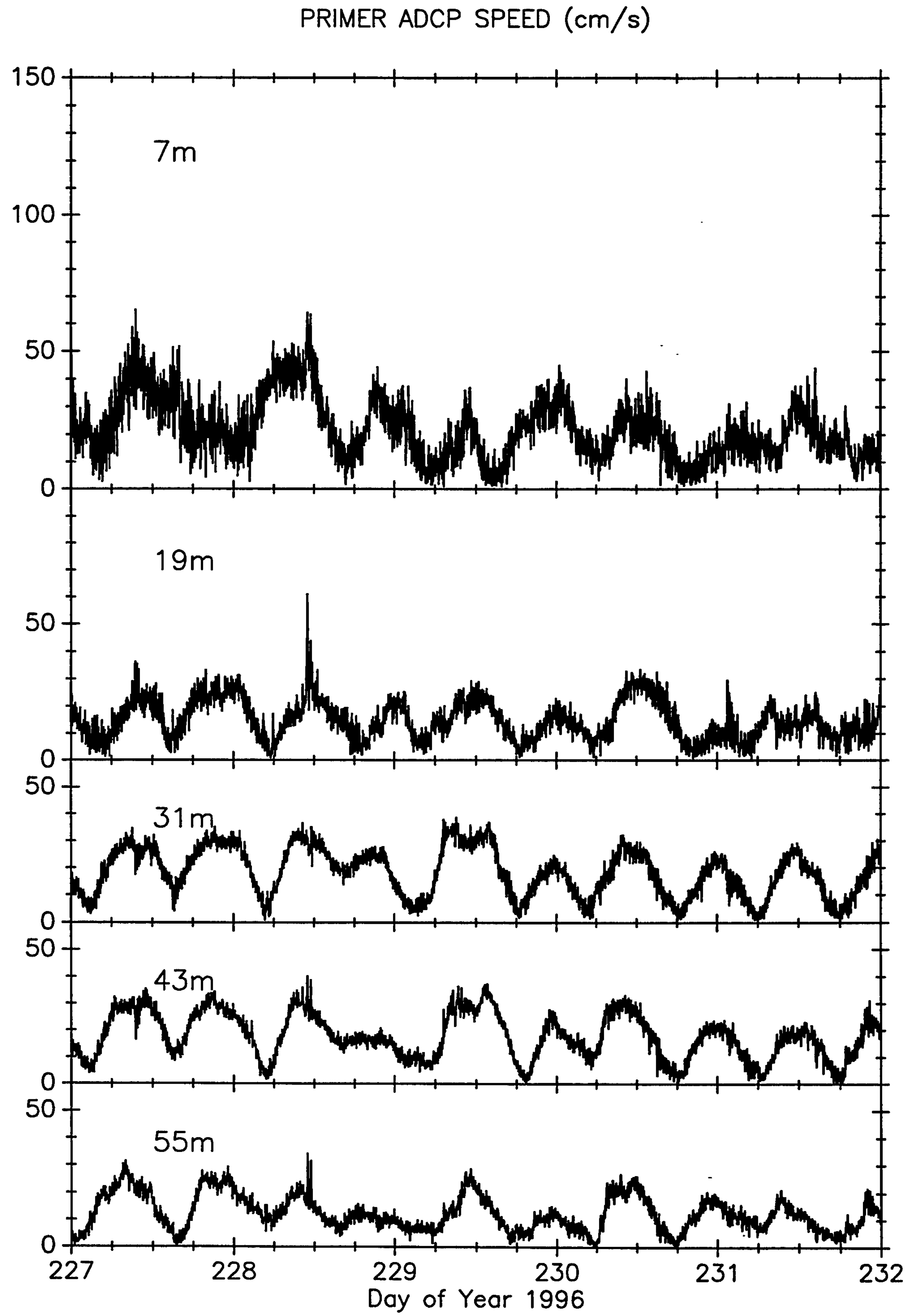
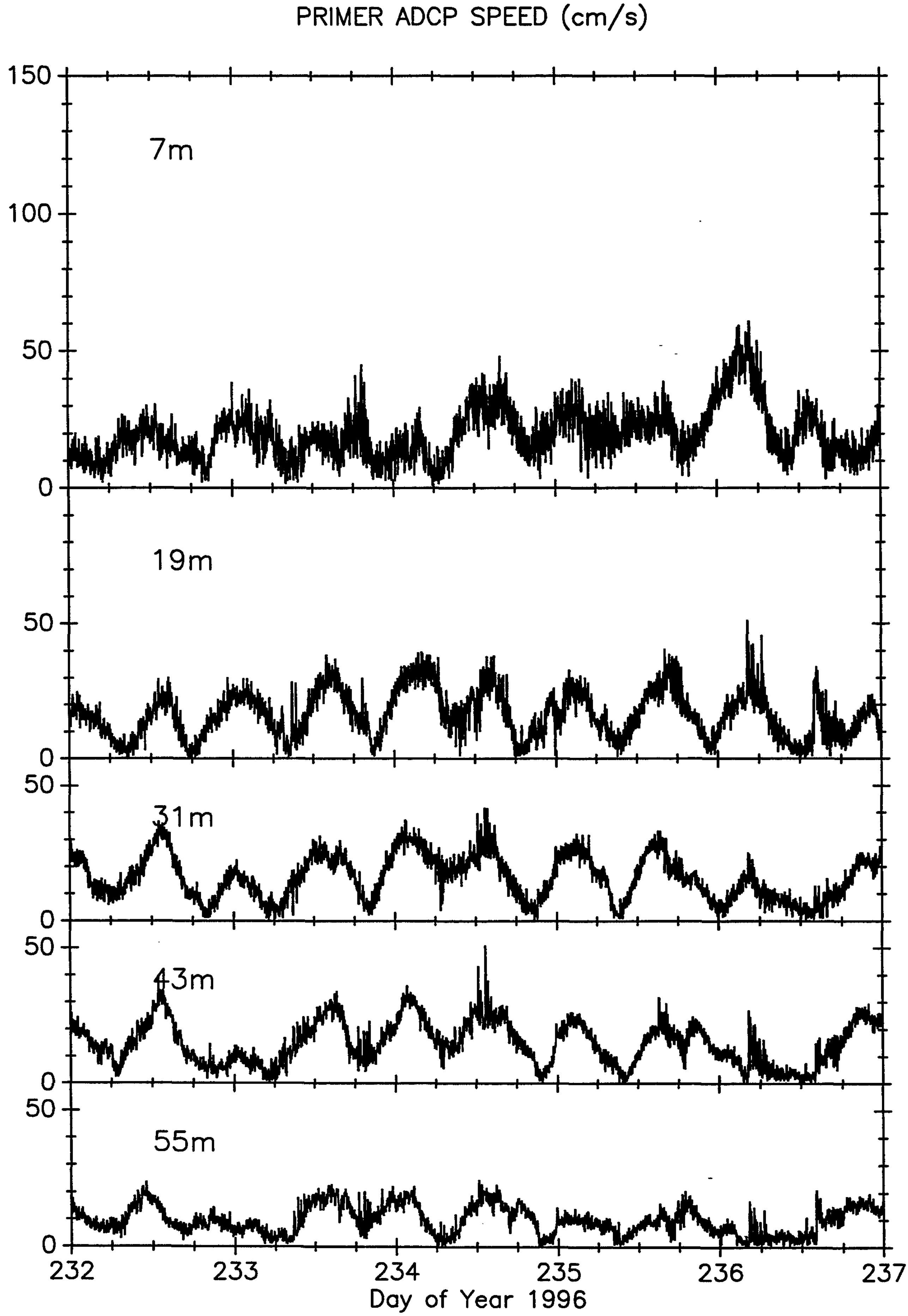
207
208
209
210
211
212
Day of Year 1996

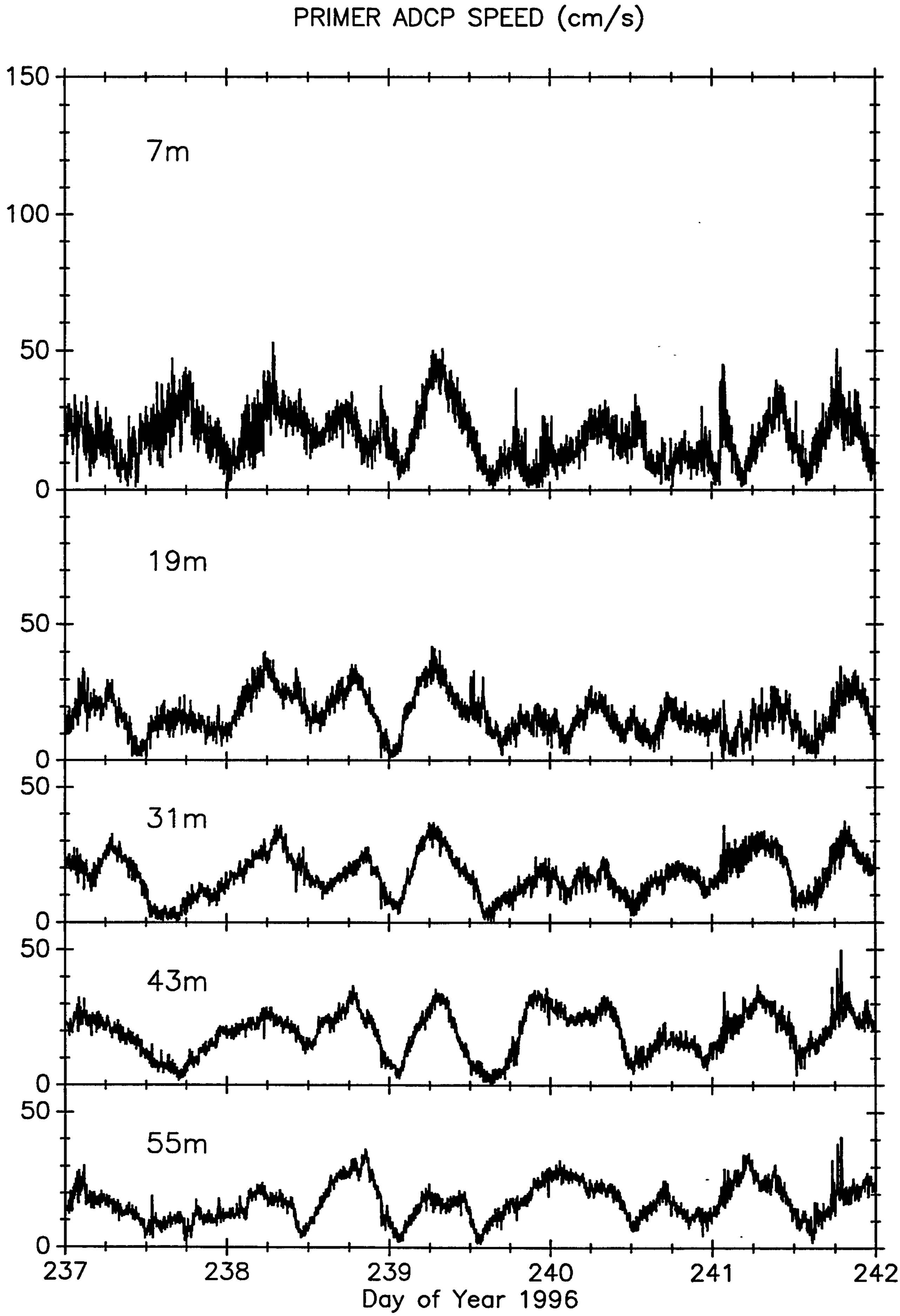

PRIMER ADCP SPEED (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
212
213
214
215
216
217
Day of Year 1996


PRIMER ADCP SPEED (cm/s)
150
100
50
0
7m
19m
31m
43m
55m
217
218
219
220
221
222
Day of Year 1996


PRIMER ADCP SPEED (cm/s)
150
100
50
0
7m
50
0
19m
50
0
31m
50
0
43m
50
0
55m
222
223
224
225
226
227
Day of Year 1996


PRIMER ADCP SPEED (cm/s)
150
100
50
0
7m
19m
31m
43m
55m
227
228
229
230
231
232
Day of Year 1996


PRIMER ADCP SPEED (cm/s)
150
100
50
0
7m
19m
31m
43m
55m
232
233
234
235
236
237
Day of Year 1996


PRIMER ADCP SPEED (cm/s)
150
100
50
0
7m
19m
50
0
50
31m
0
50
43m
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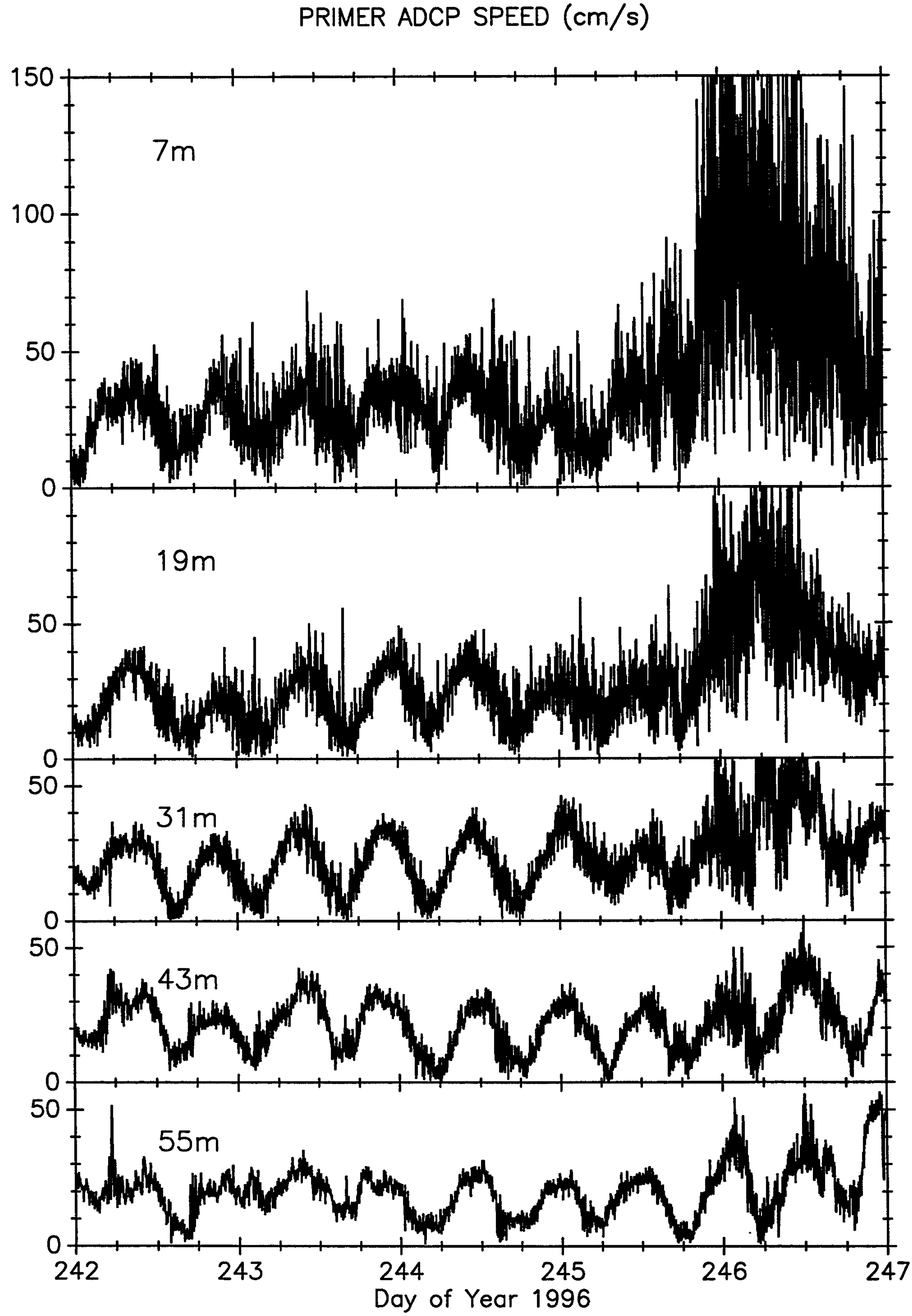
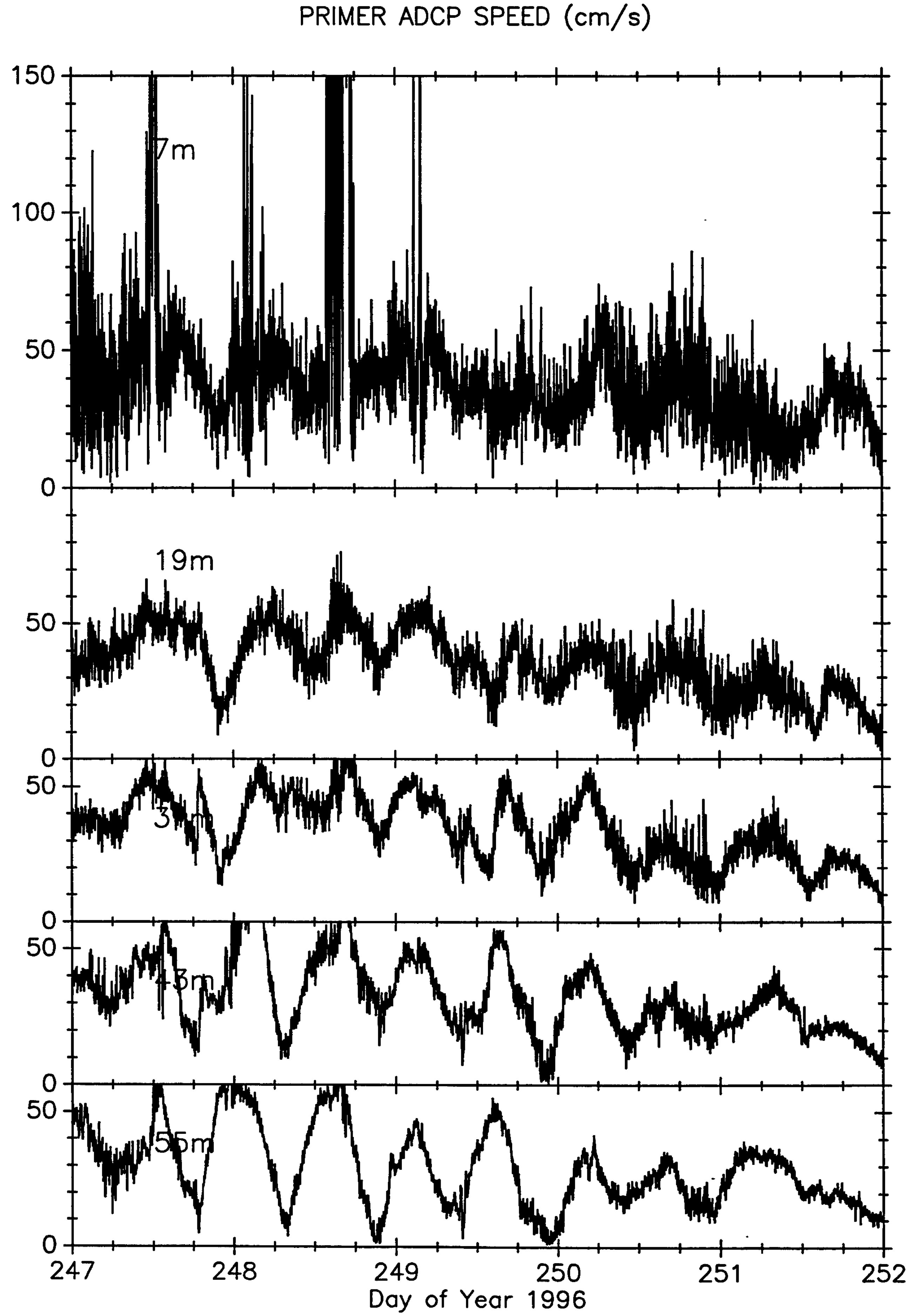
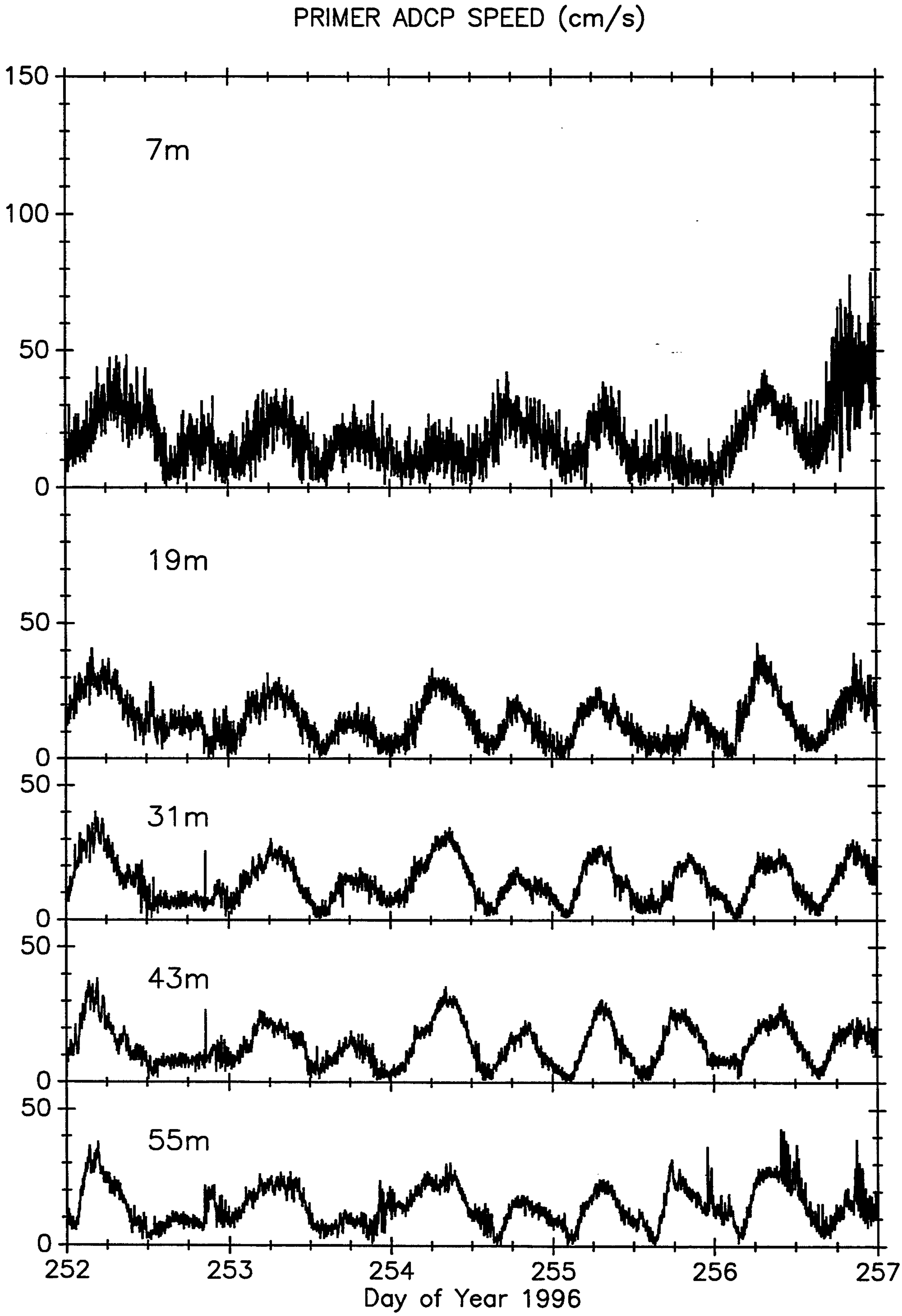
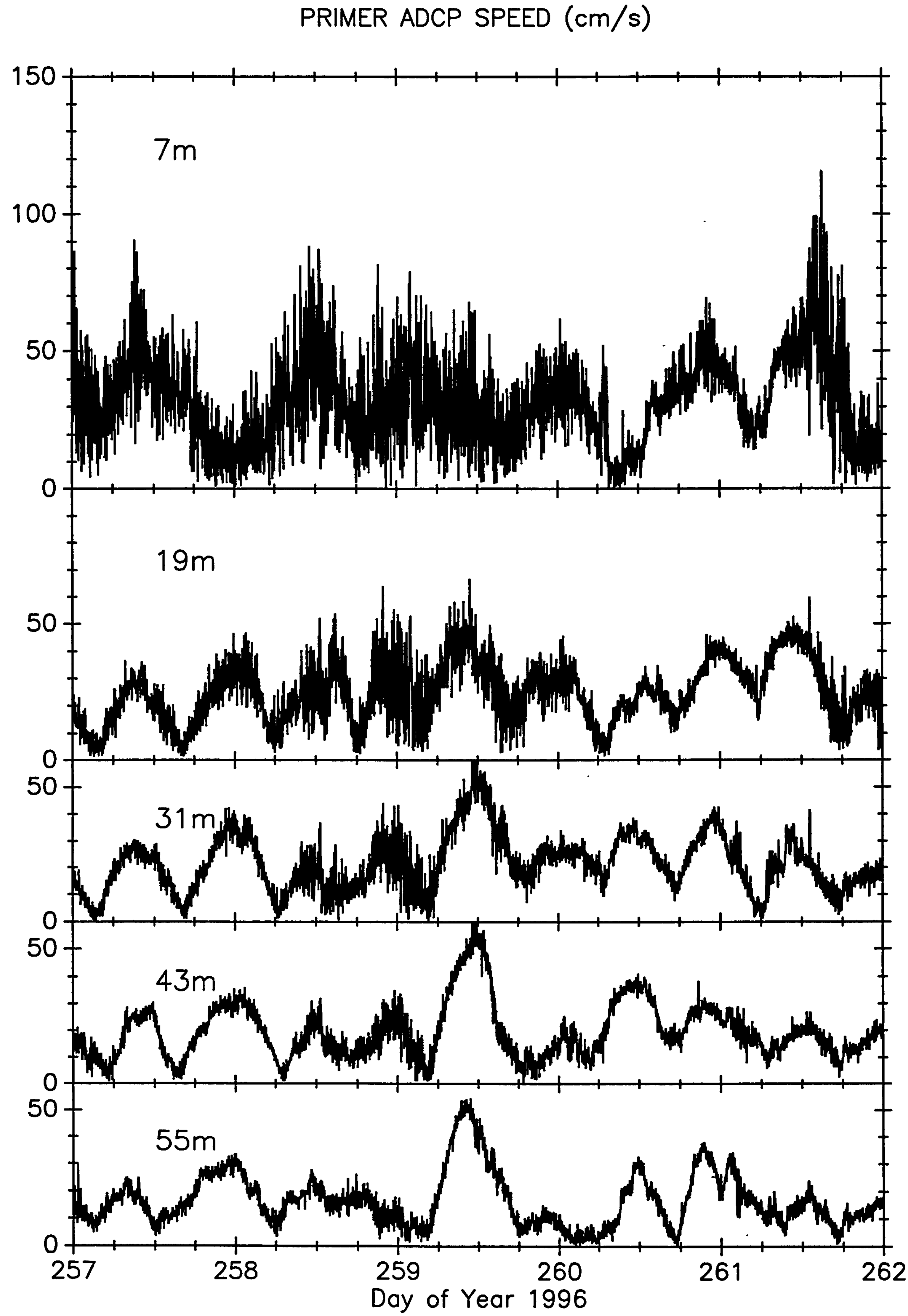
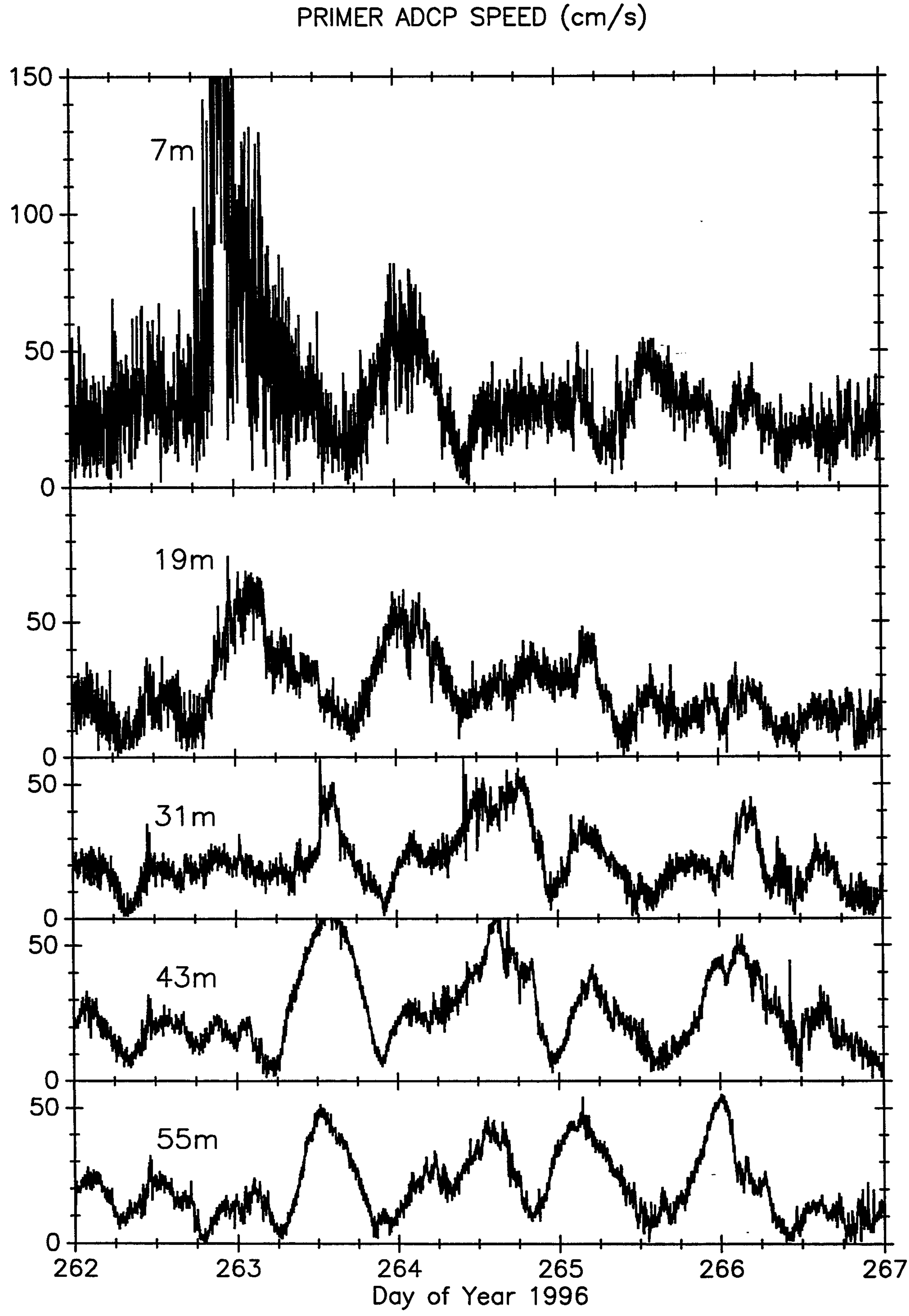
55m
0
237
238
239
240
241
242
Day of Year 1996

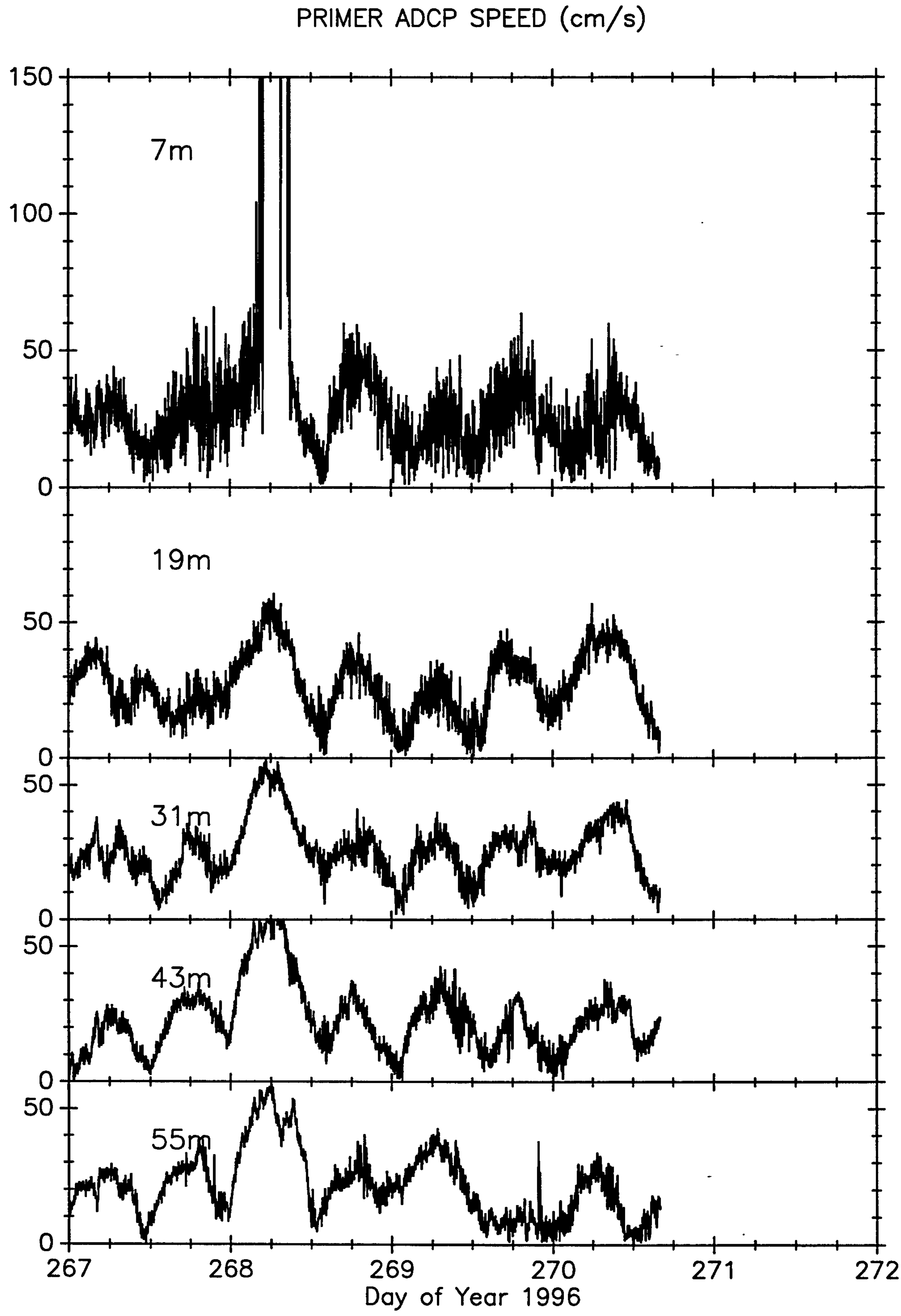

PRIMER ADCP SPEED (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
242
243
244
245
246
247
Day of Year 1996


PRIMER ADCP SPEED (cm/s)
150
100
50
0
7m
19m
31m
43m
55m
247
248
249
250
251
252
Day of Year 1996


PRIMER ADCP SPEED (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
252
253
254
255
256
257
Day of Year 1996


PRIMER ADCP SPEED (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
257
258
259
260
261
262
Day of Year 1996


PRIMER ADCP SPEED (cm/s)
7m
19m
31m
43m
55m
150
100
50
0
262
263
264
265
266
267
Day of Year 1996

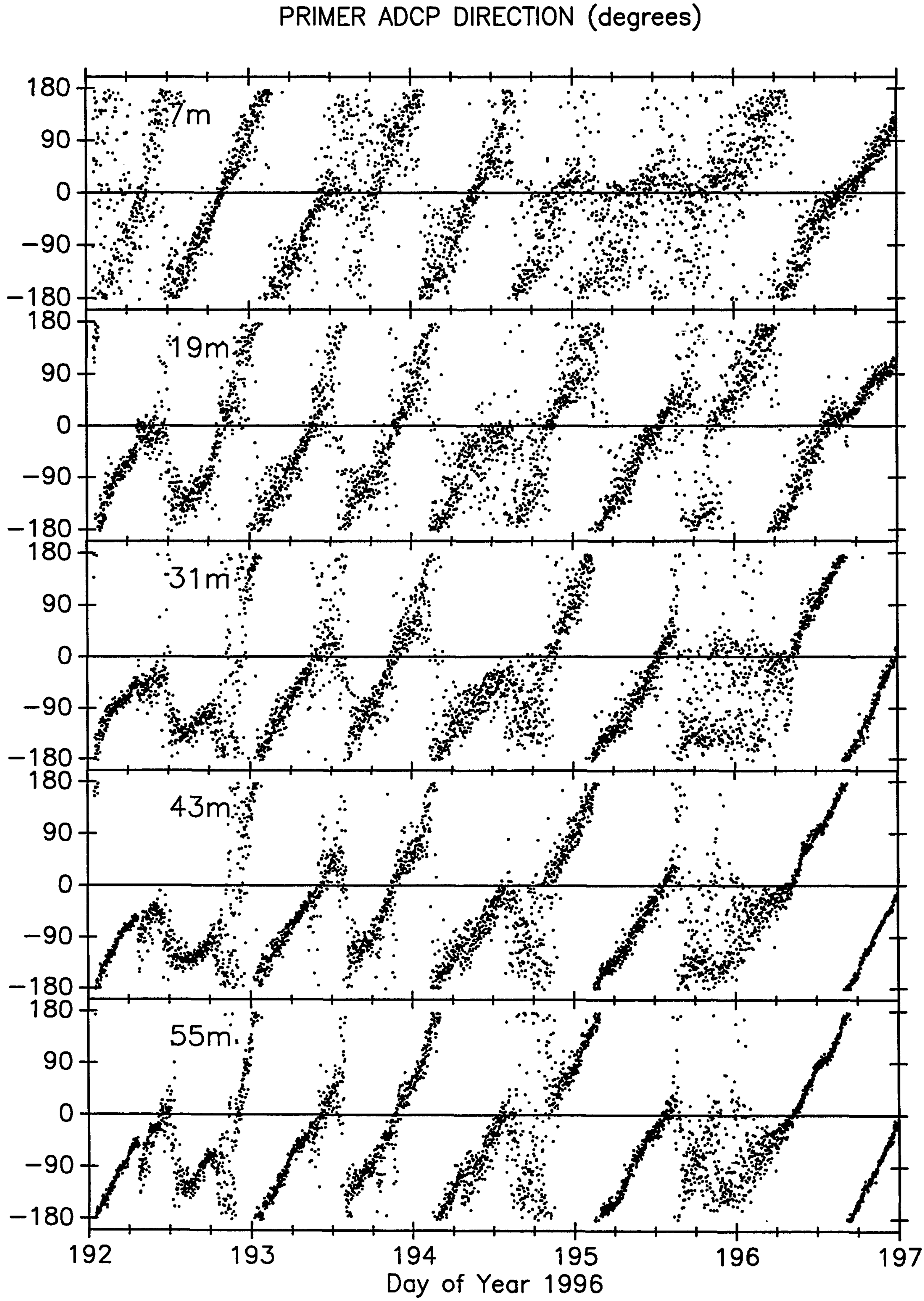

PRIMER ADCP SPEED (cm/s)
150
100
50
0
7m
19m
31m
43m
55m
267
268
269
270
271
272
Day of Year 1996

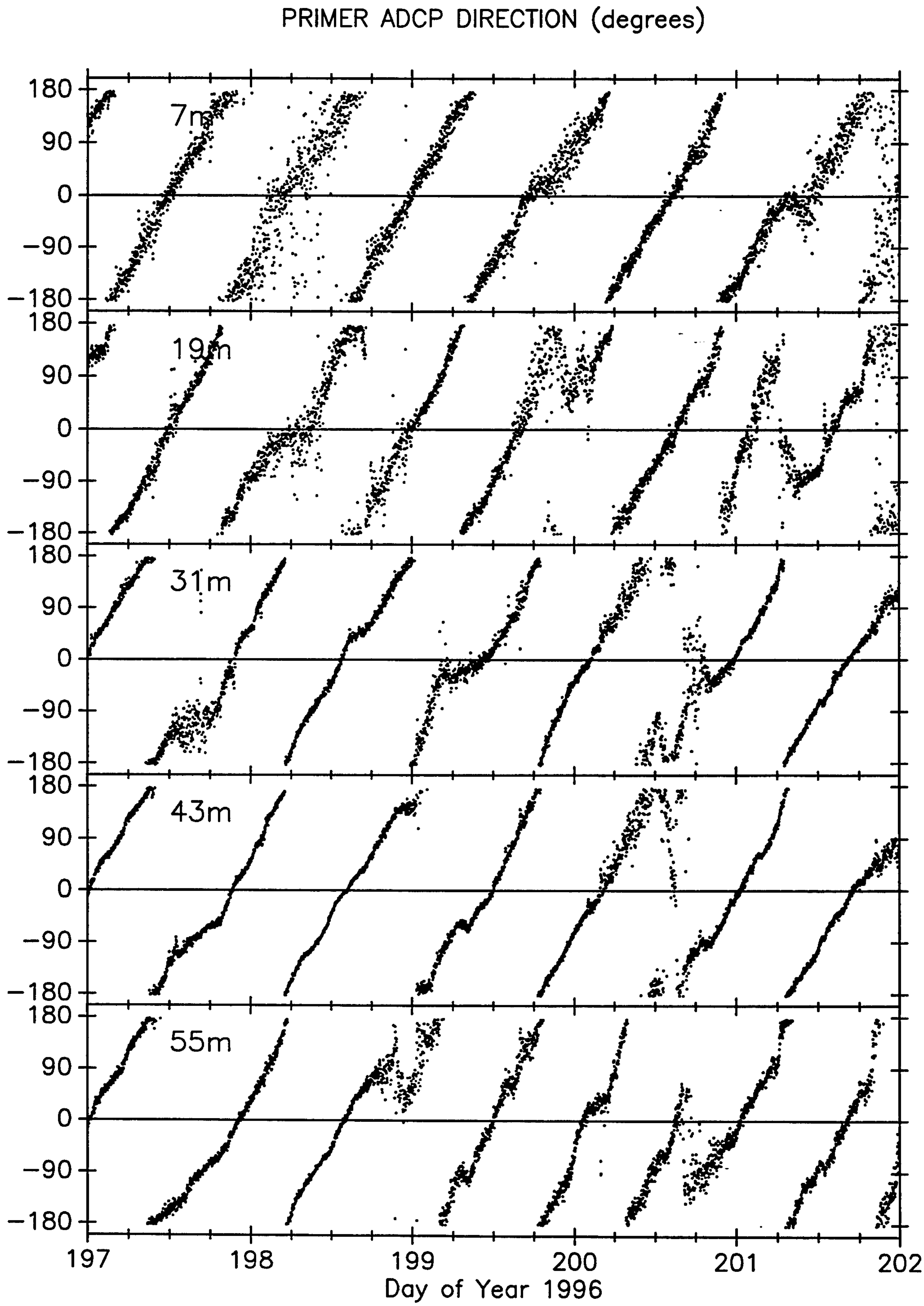
DIRECTION (ADCP) Time Series

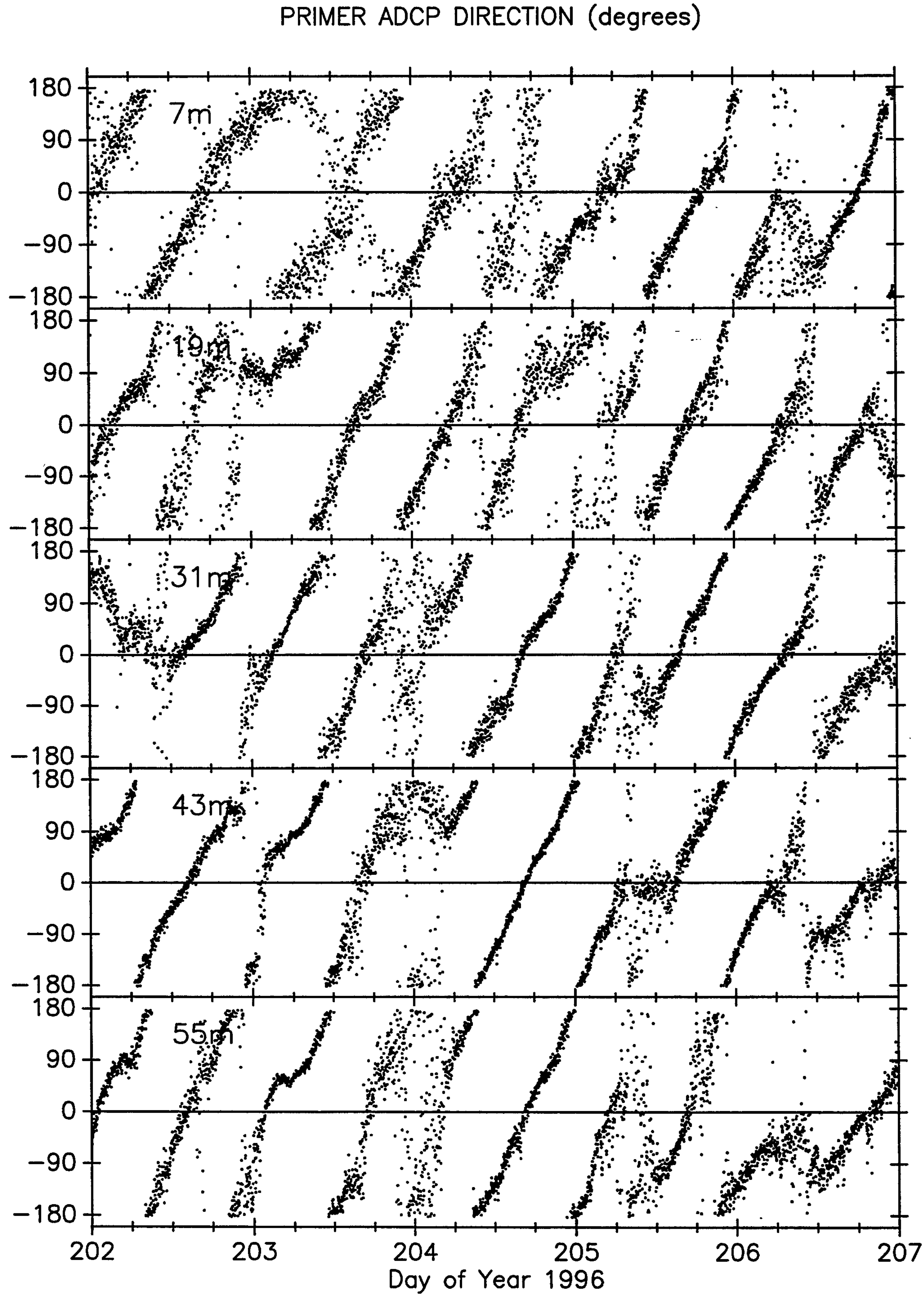
Main Mooring

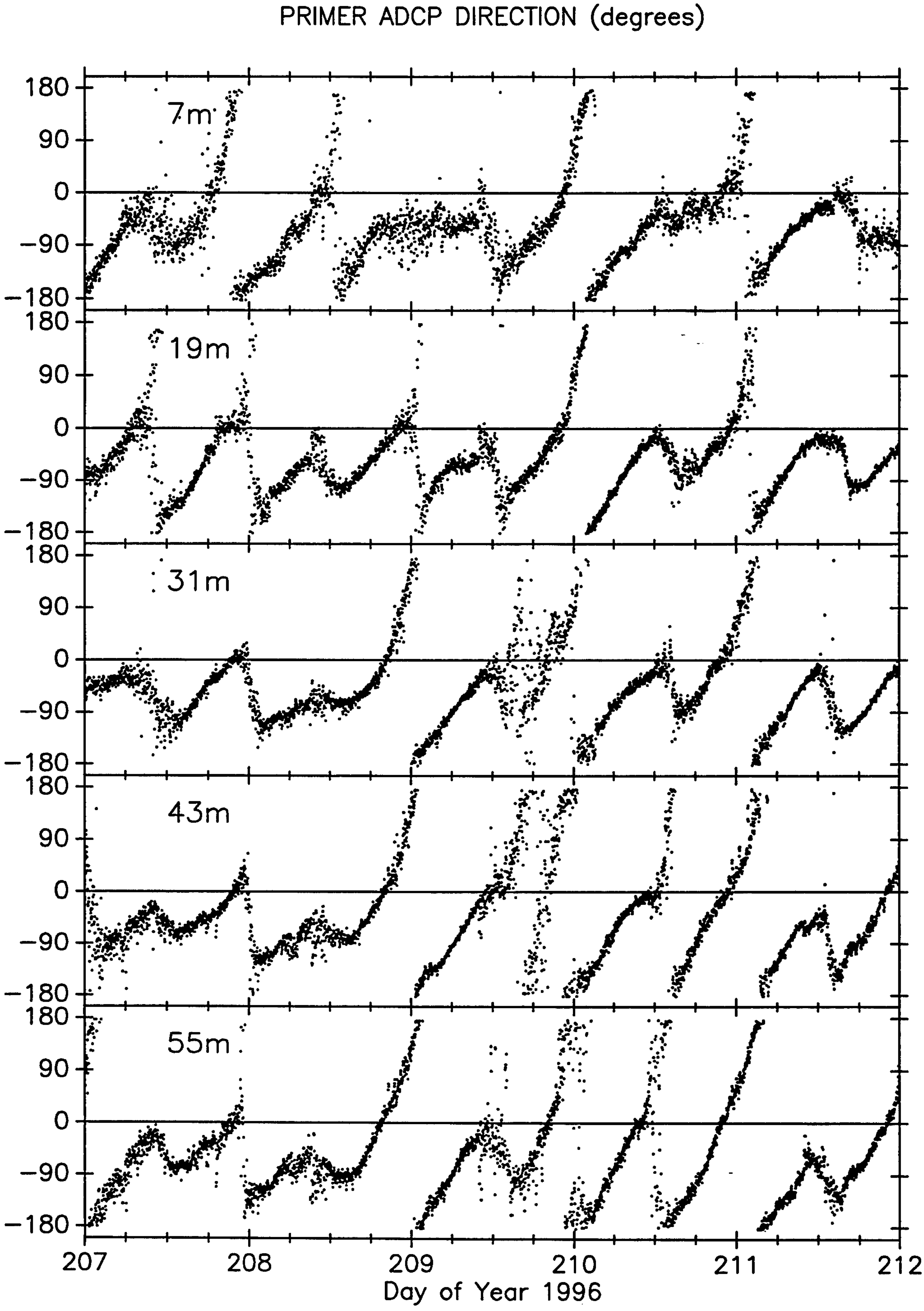
Unfiltered

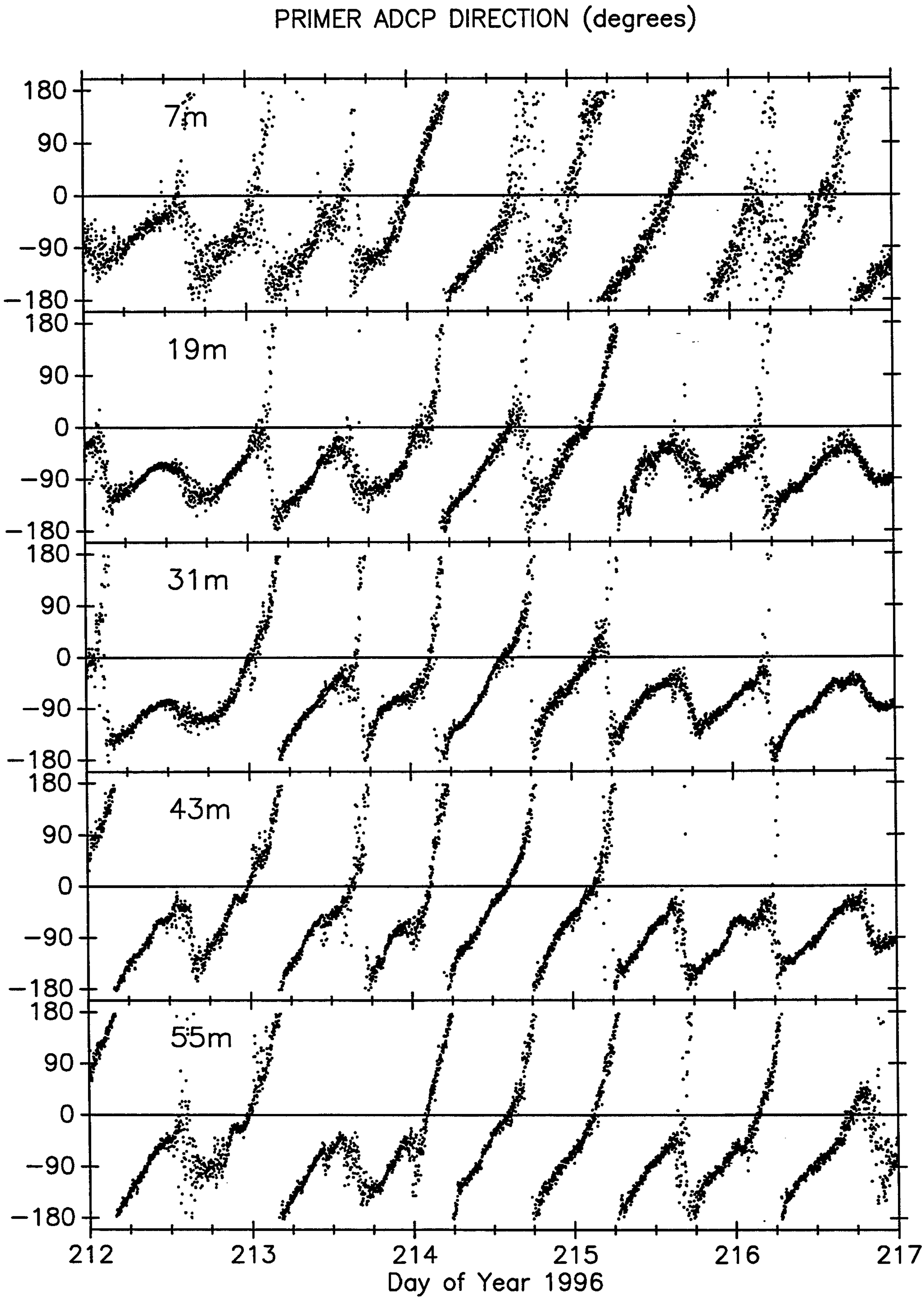
ADCP direction of vector velocity from 4-meter bins centered at 7 m, 19 m, 31 m, 43 m, and 55 m on the Main mooring. Velocity components are not filtered. The ADCP generates a vector-averaged velocity sample at two minute intervals. Direction of the current is clockwise from North: North is 0° and East is 90°.

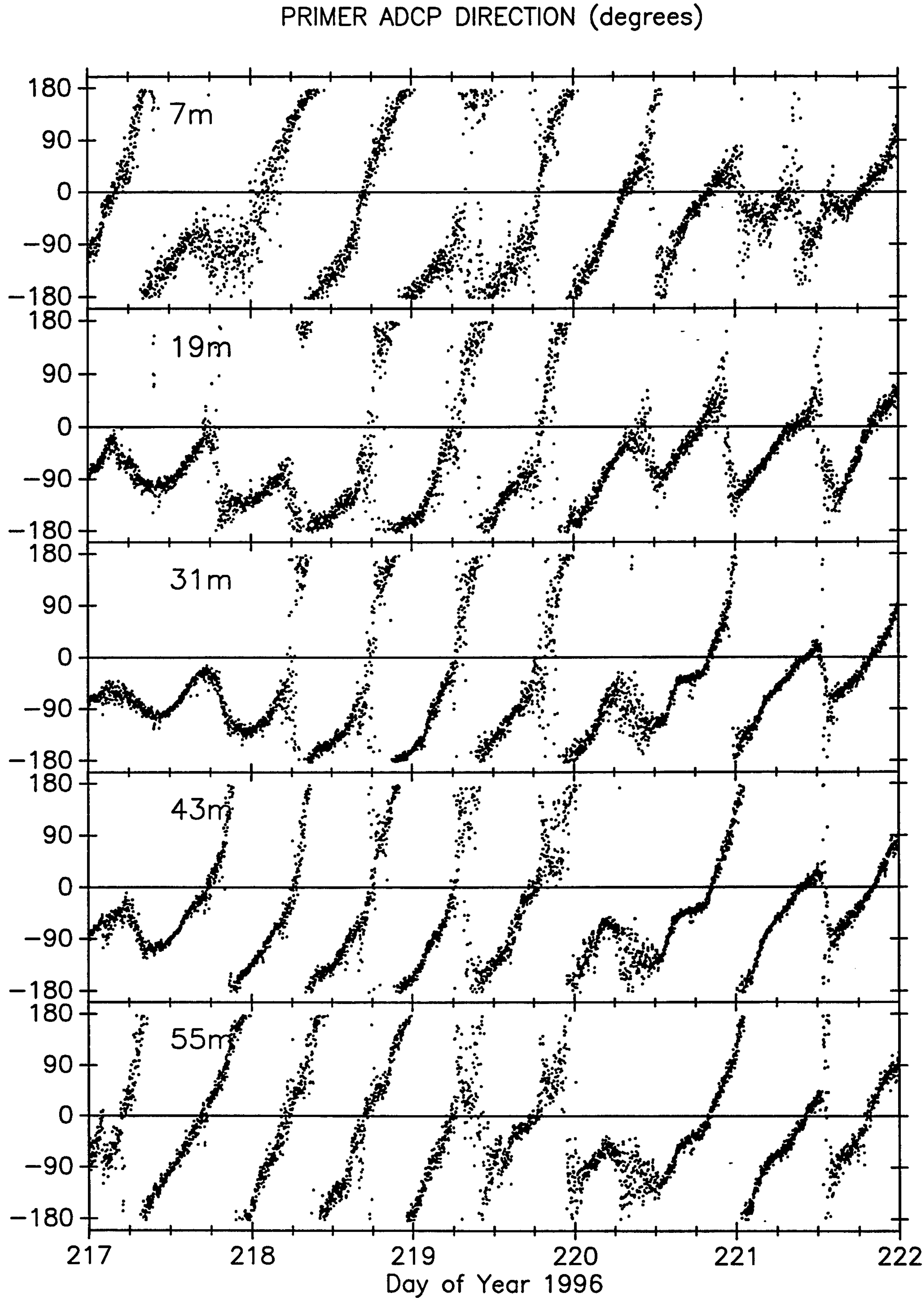

PRIMER ADCP DIRECTION (degrees)
7m
19m
31m
43m
55m
180
90
0
−90
−180
192
193
194
195
196
197
Day of Year 1996

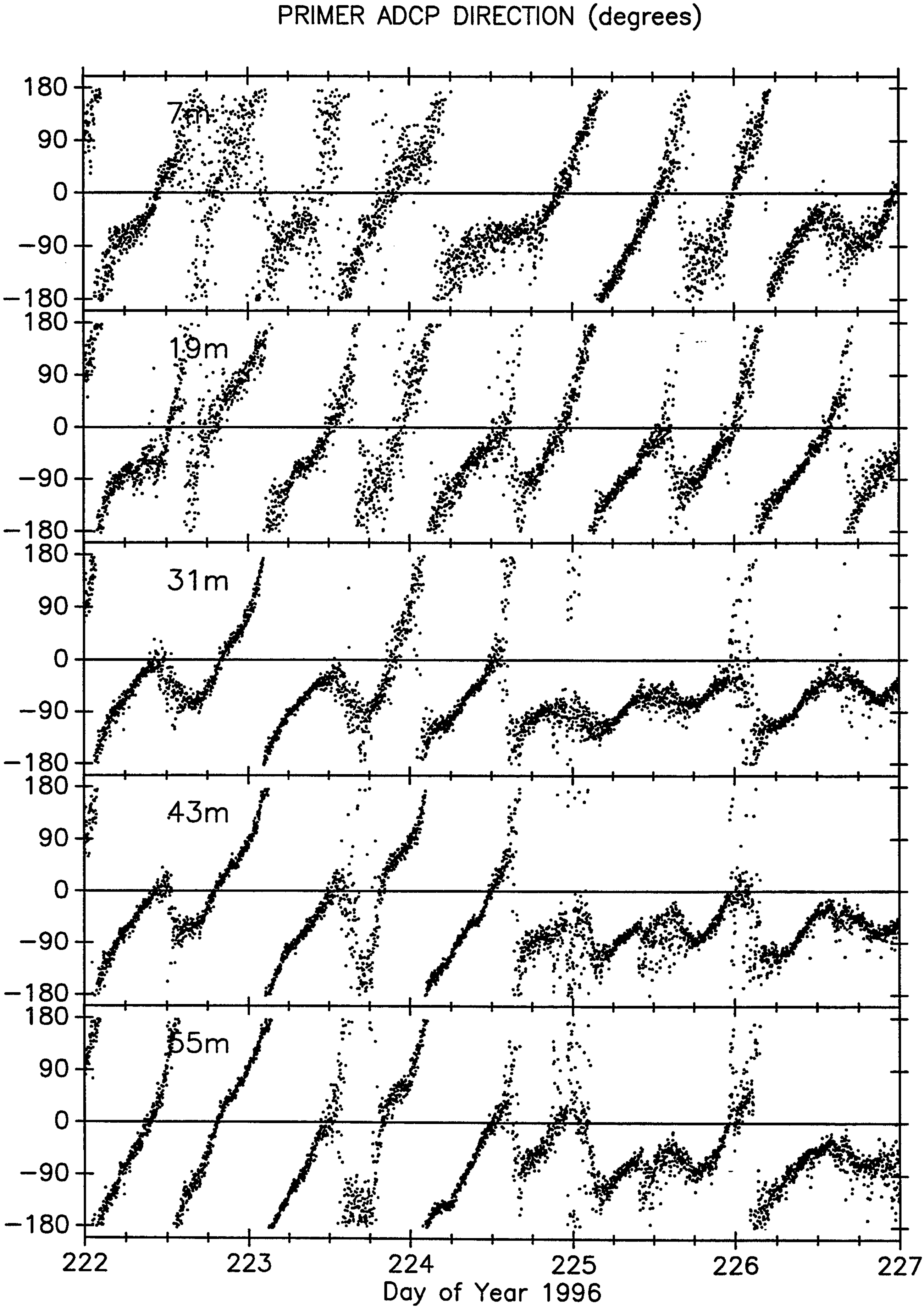

PRIMER ADCP DIRECTION (degrees)
7m
19m
31m
43m
55m
180
90
0
−90
−180
197
198
199
200
201
202
Day of Year 1996


PRIMER ADCP DIRECTION (degrees)
7m
19m
31m
43m
55m
180
90
0
−90
−180
202
203
204
205
206
207
Day of Year 1996

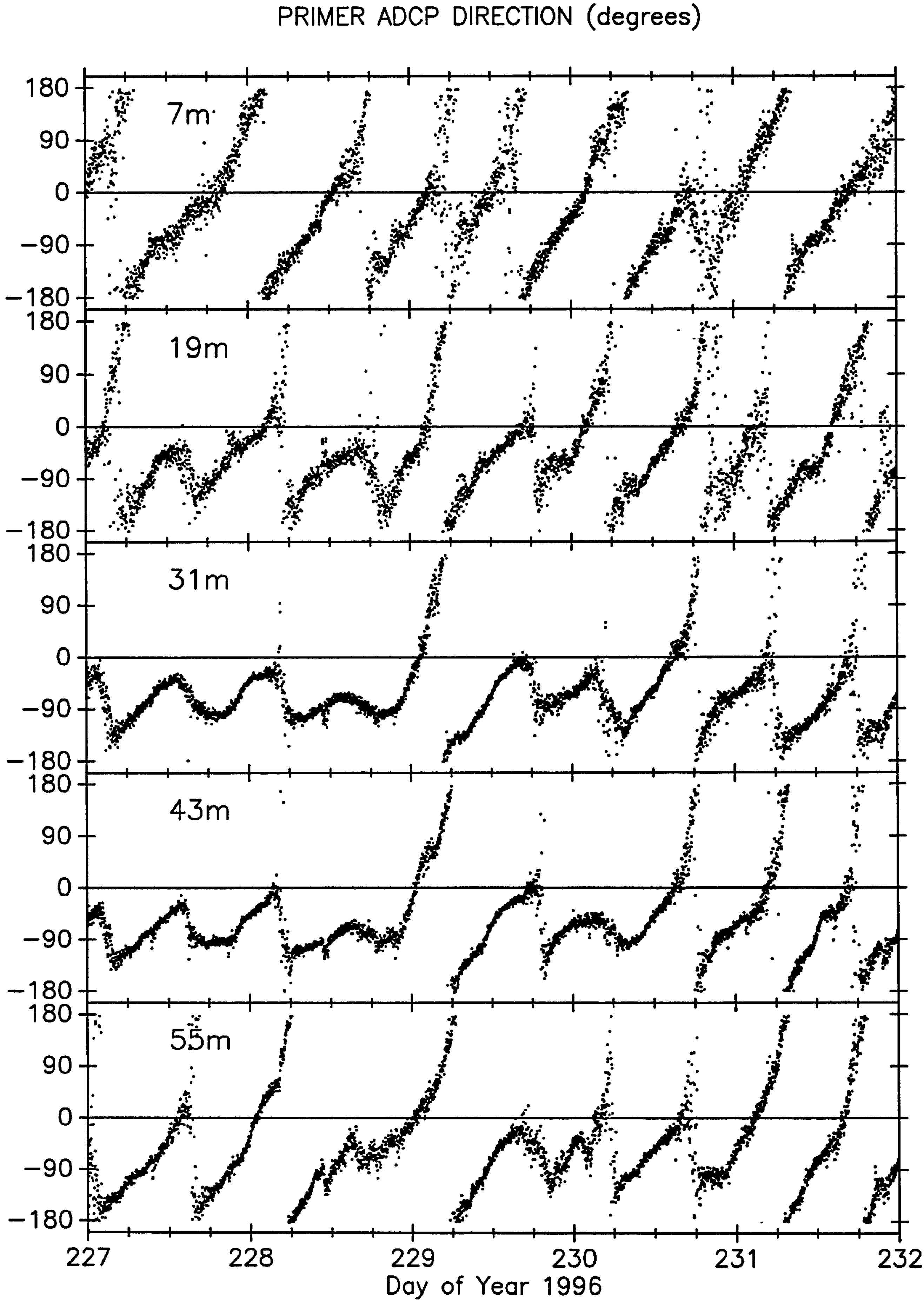

PRIMER ADCP DIRECTION (degrees)
7m
19m
31m
43m
55m
180
90
0
−90
−180
207
208
209
210
211
212
Day of Year 1996

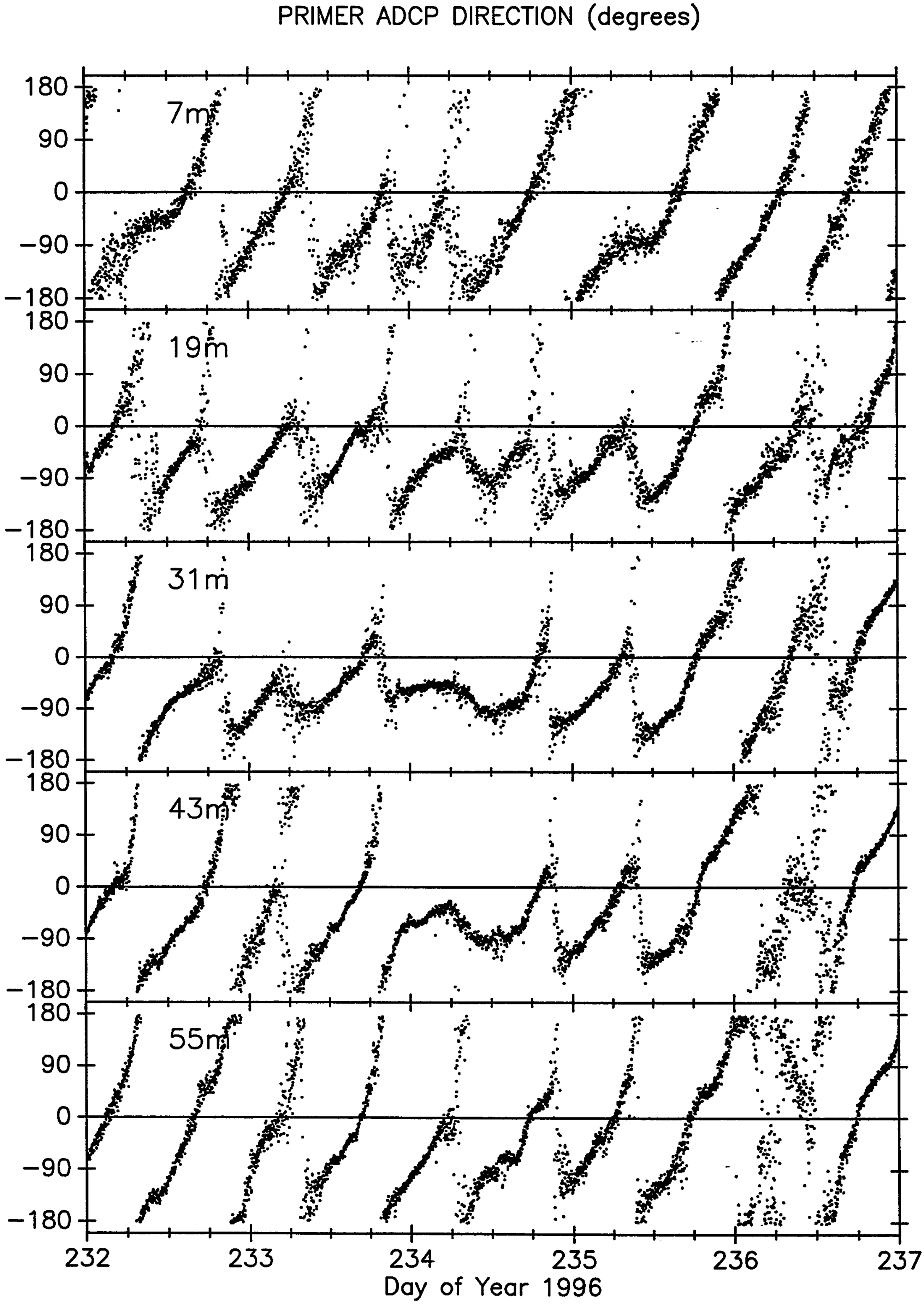

PRIMER ADCP DIRECTION (degrees)
7m
19m
31m
43m
55m
180
90
0
−90
−180
212
213
214
215
216
217
Day of Year 1996


PRIMER ADCP DIRECTION (degrees)
7m
19m
31m
43m
55m
180
90
0
−90
−180
217
218
219
220
221
222
Day of Year 1996

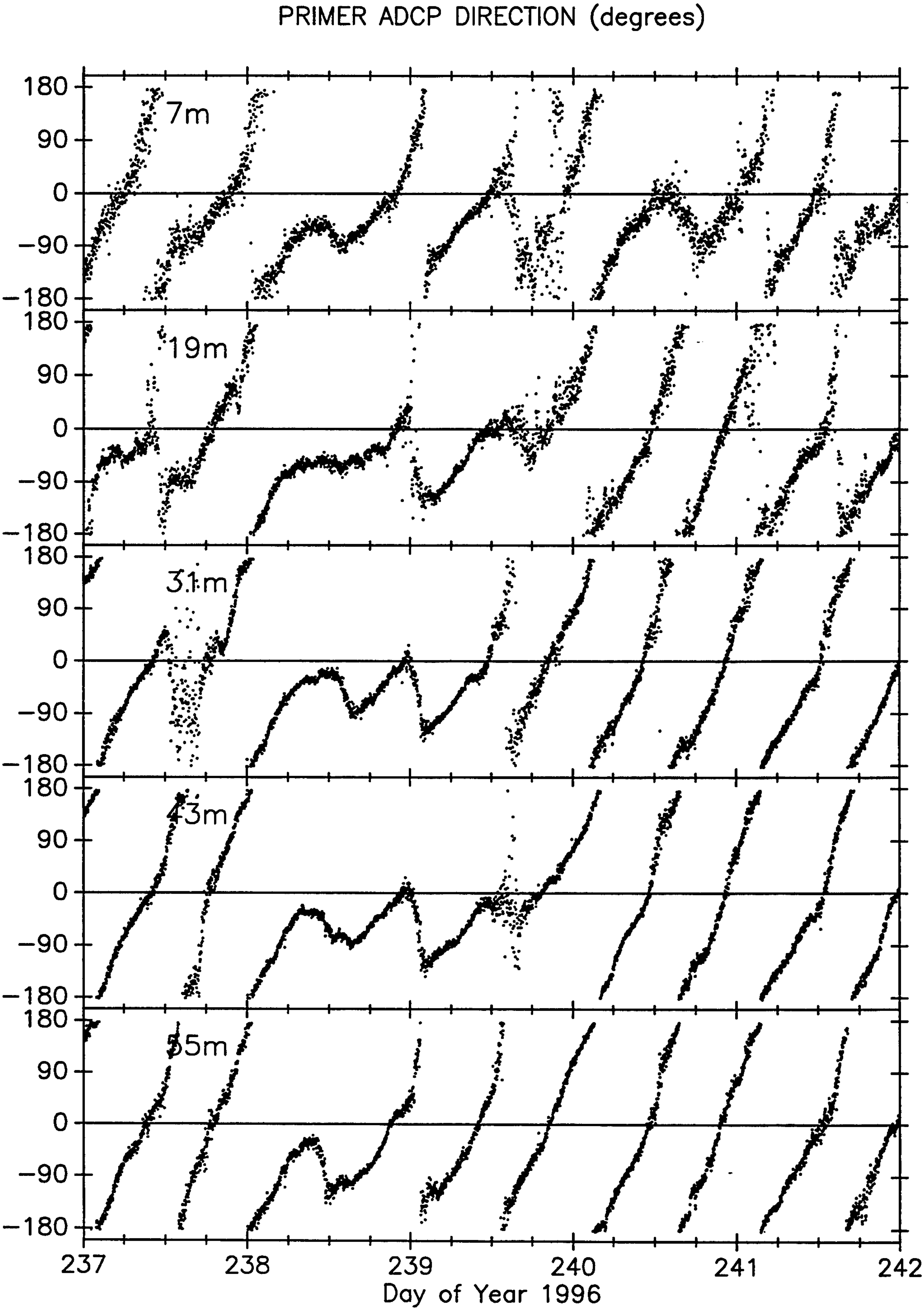


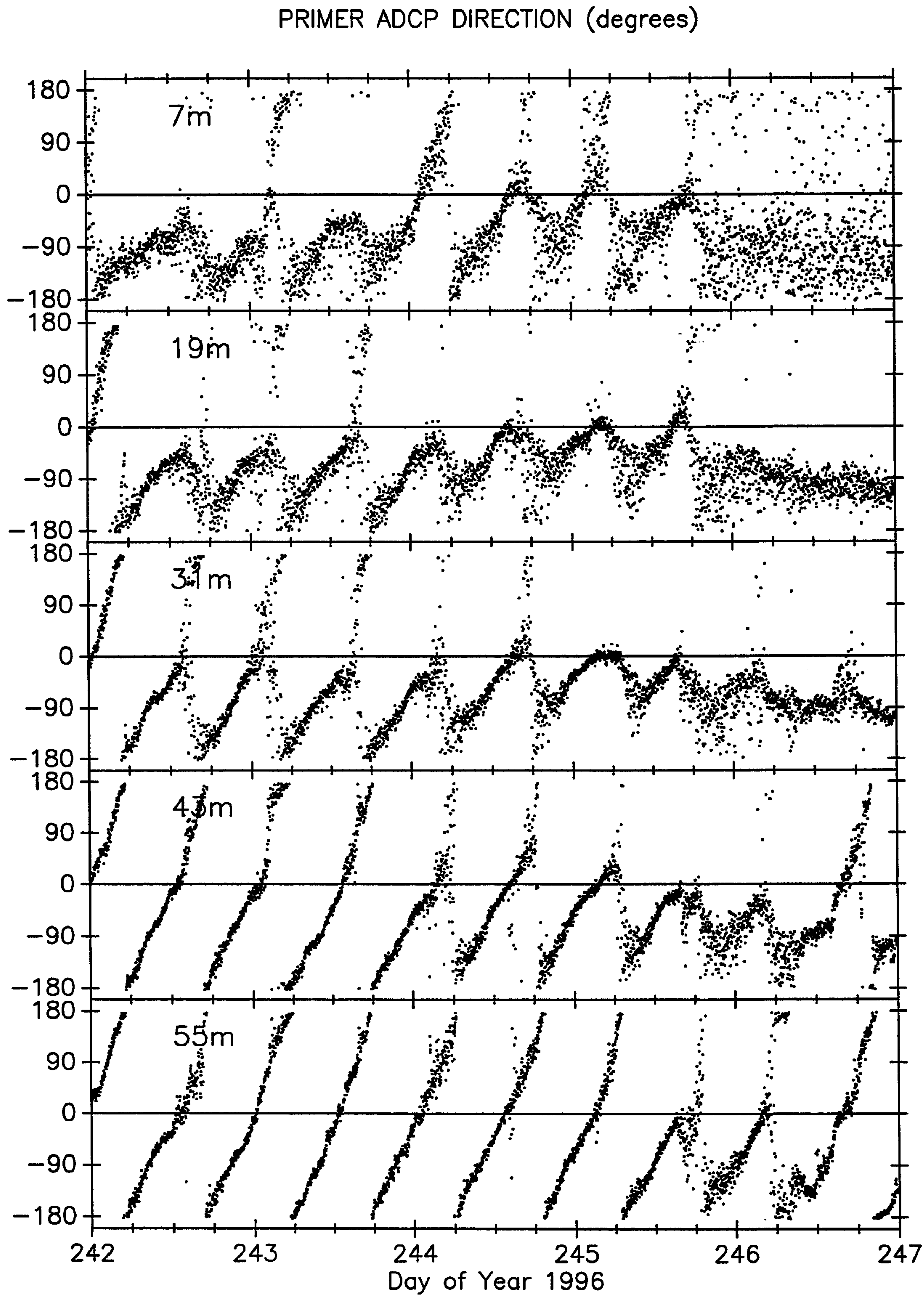
PRIMER ADCP DIRECTION (degrees)
180
90
0
−90
−180
7m
19m
31m
43m
55m
222
223
224
225
226
227
Day of Year 1996

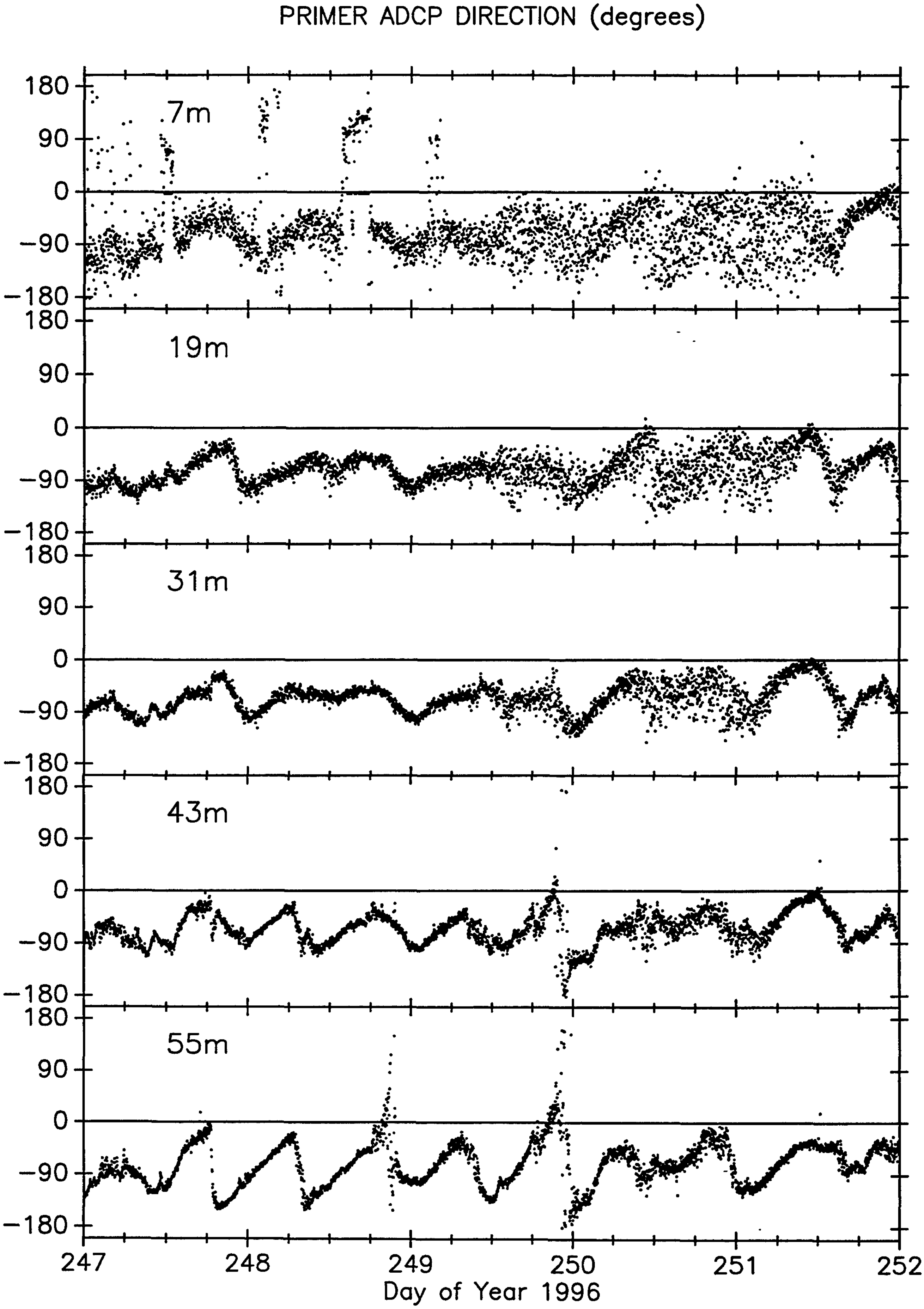

PRIMER ADCP DIRECTION (degrees)
7m
19m
31m
43m
55m
180
90
0
−90
−180
227
228
229
230
231
232
Day of Year 1996

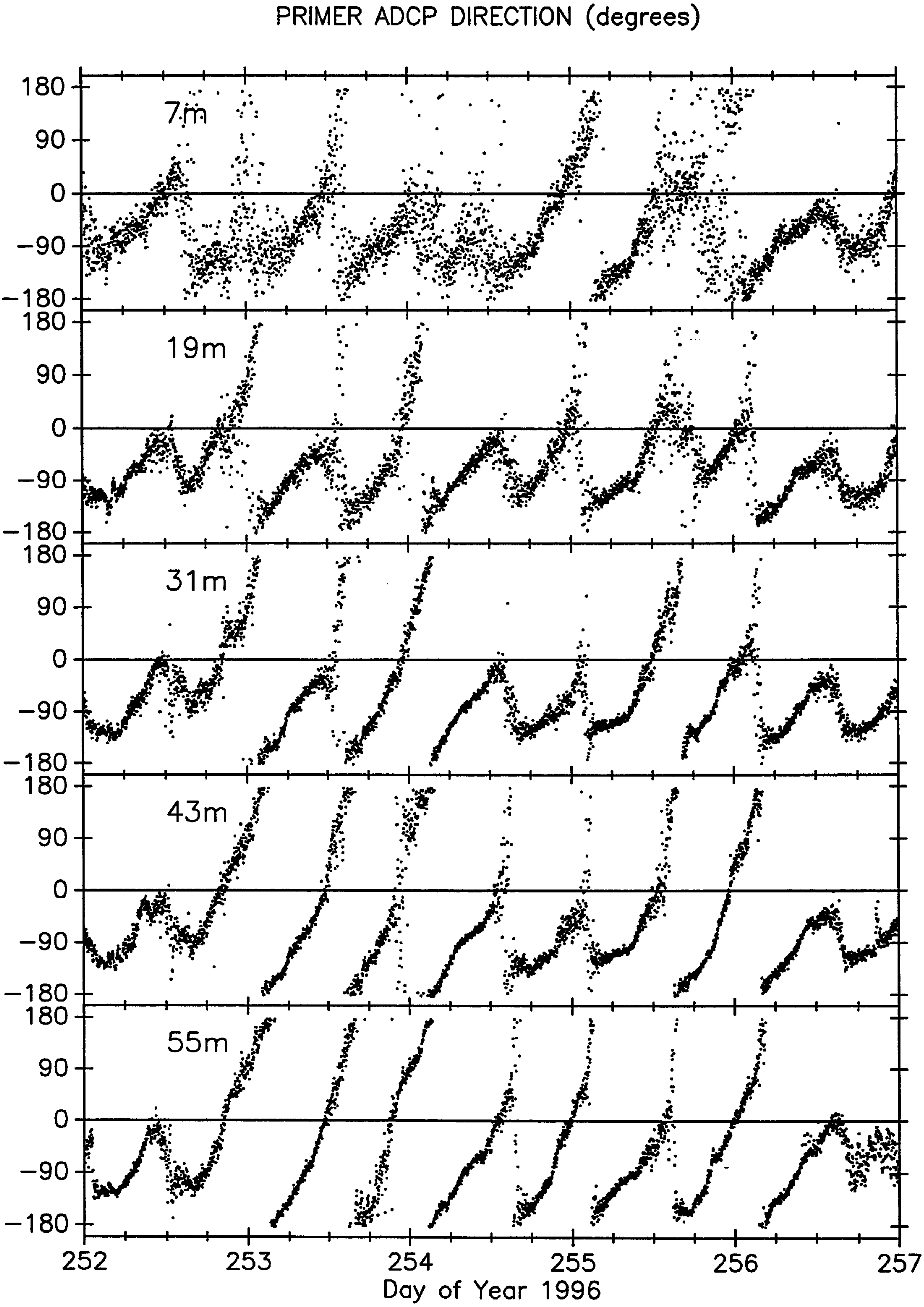


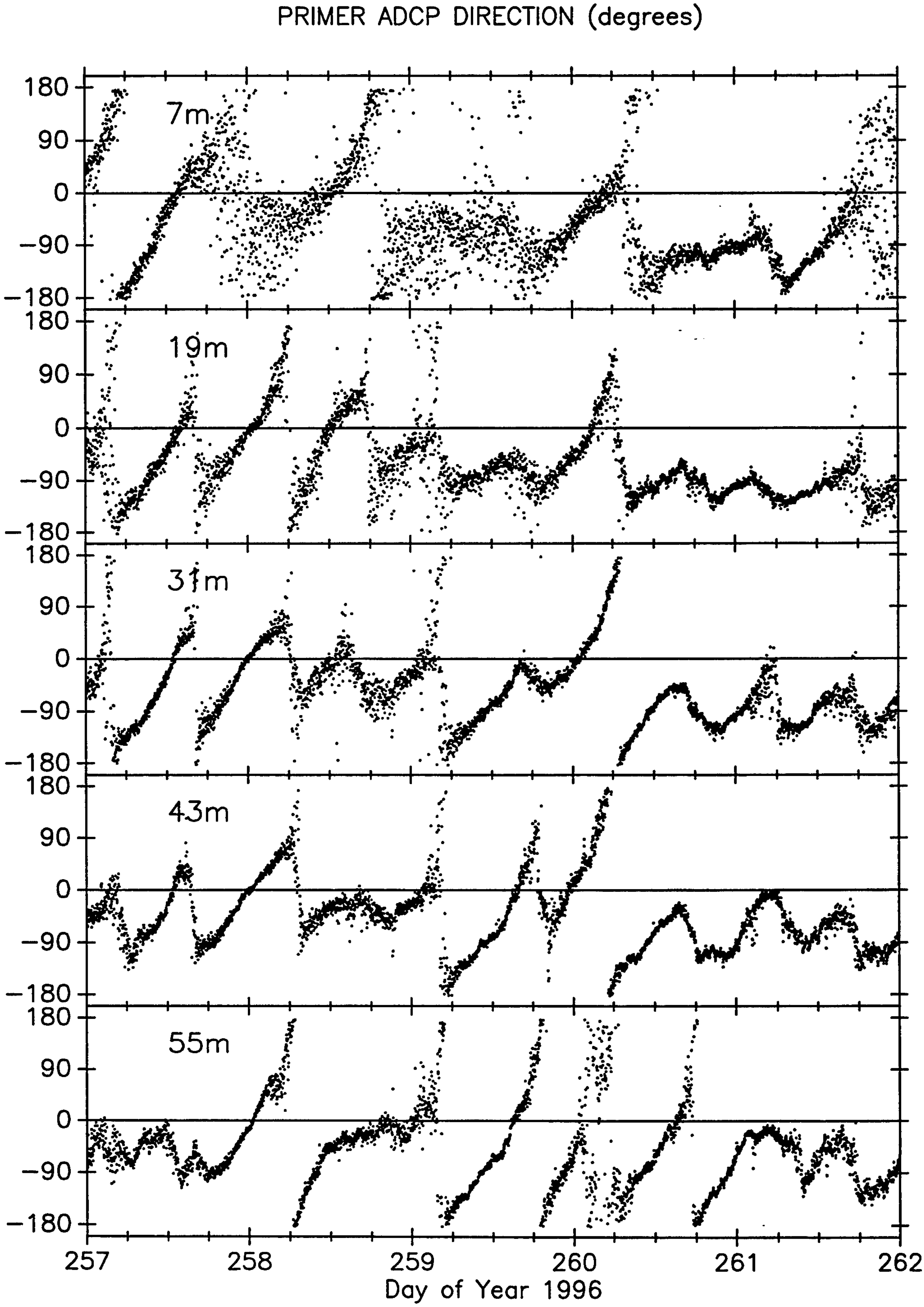
PRIMER ADCP DIRECTION (degrees)
7m
19m
31m
43m
55m
180
90
0
−90
−180
232
233
234
235
236
237
Day of Year 1996

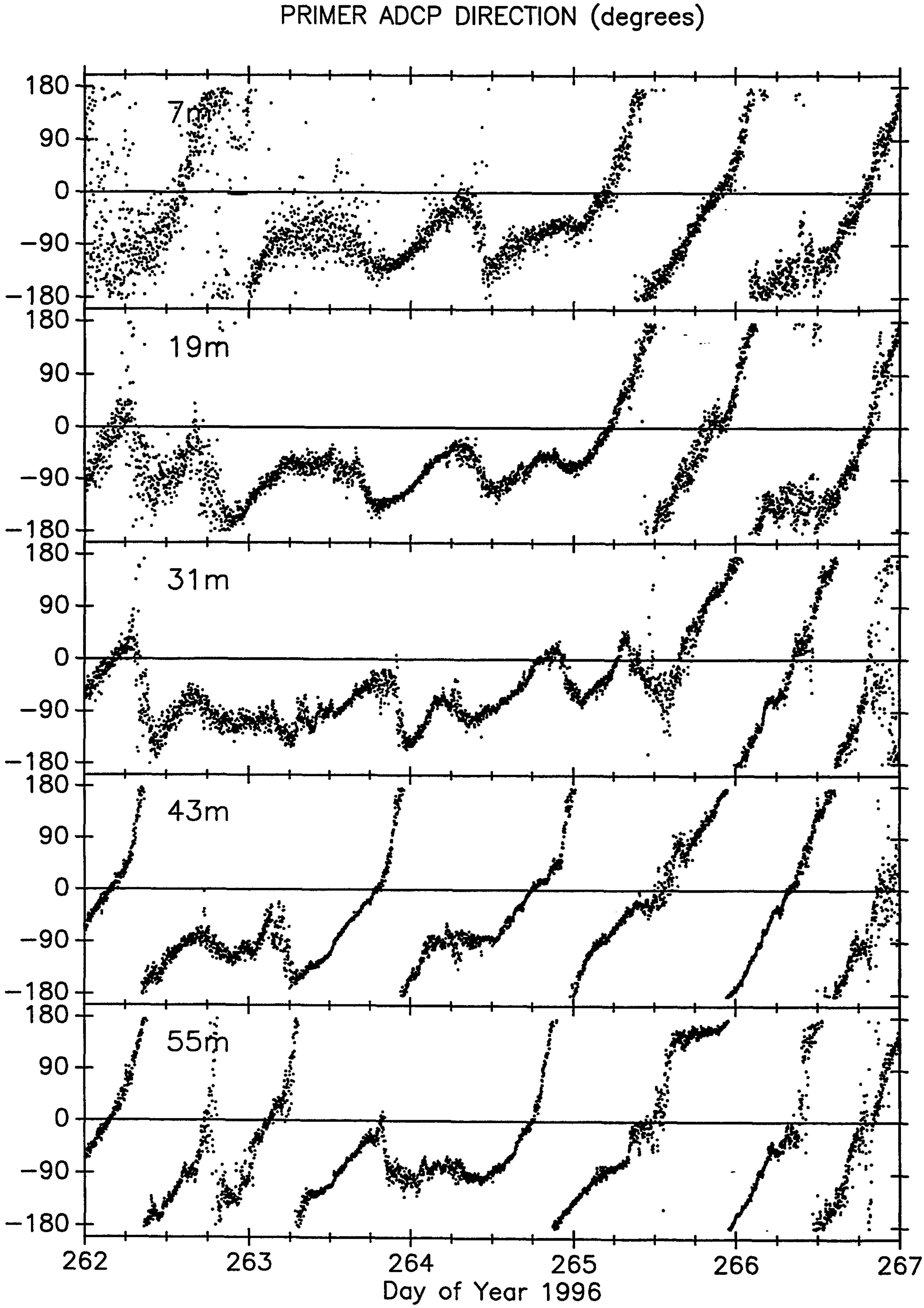

PRIMER ADCP DIRECTION (degrees)
7m
19m
31m
43m
55m
180
90
0
−90
−180
237
238
239
240
241
242
Day of Year 1996

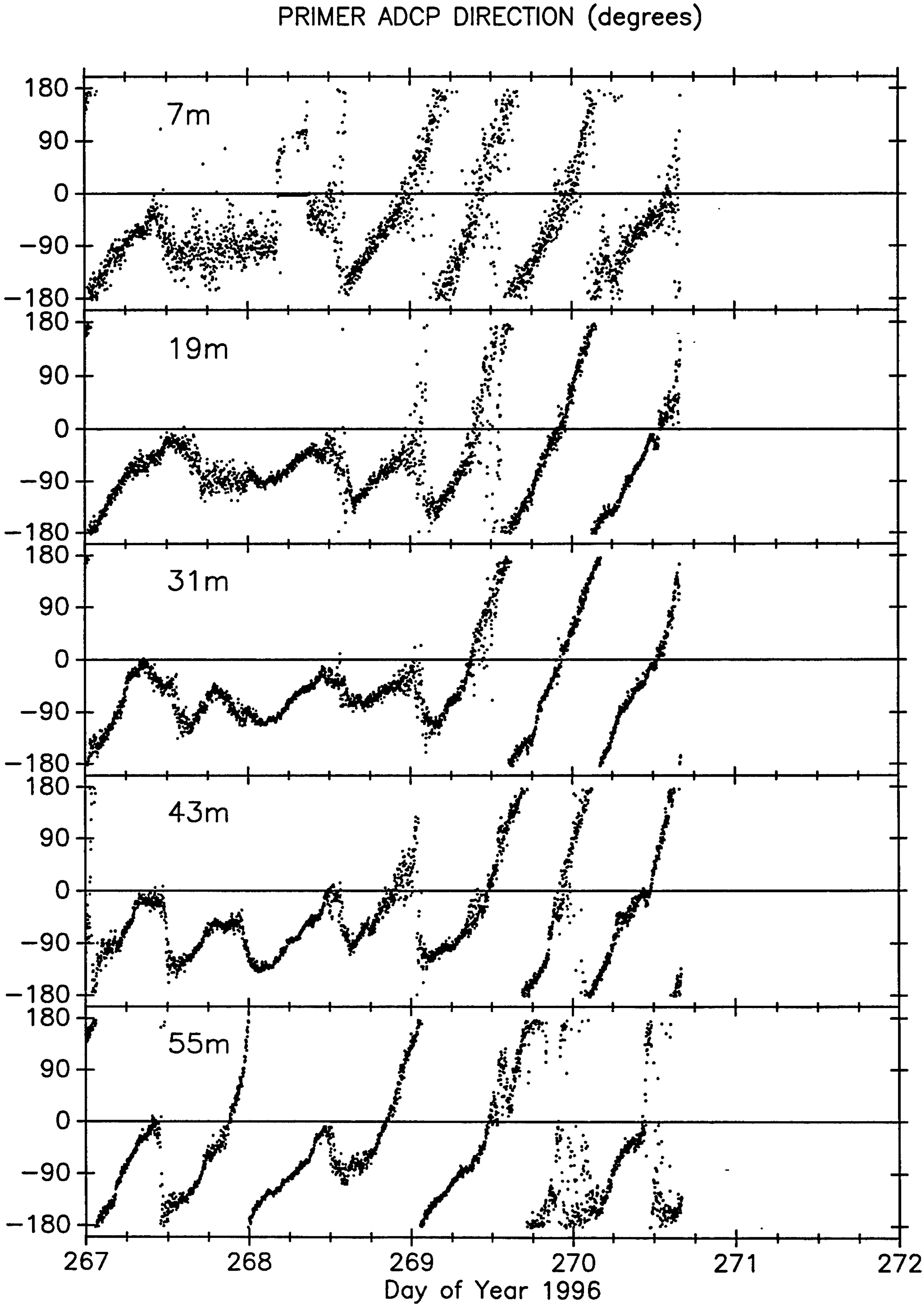

PRIMER ADCP DIRECTION (degrees)
7m
19m
31m
43m
55m
180
90
0
−90
−180
242
243
244
245
246
247
Day of Year 1996


PRIMER ADCP DIRECTION (degrees)
7m
19m
31m
43m
55m
180
90
0
−90
−180
247
248
249
250
251
252
Day of Year 1996


PRIMER ADCP DIRECTION (degrees)
7m
19m
31m
43m
55m
180
90
0
−90
−180
252
253
254
255
256
257
Day of Year 1996


PRIMER ADCP DIRECTION (degrees)
7m
19m
31m
43m
55m
180
90
0
−90
−180
257
258
259
260
261
262
Day of Year 1996


PRIMER ADCP DIRECTION (degrees)
7m
19m
31m
43m
55m
180
90
0
−90
−180
262
263
264
265
266
267
Day of Year 1996


PRIMER ADCP DIRECTION (degrees)
7m
19m
31m
43m
55m
180
90
0
−90
−180
267
268
269
270
271
272
Day of Year 1996

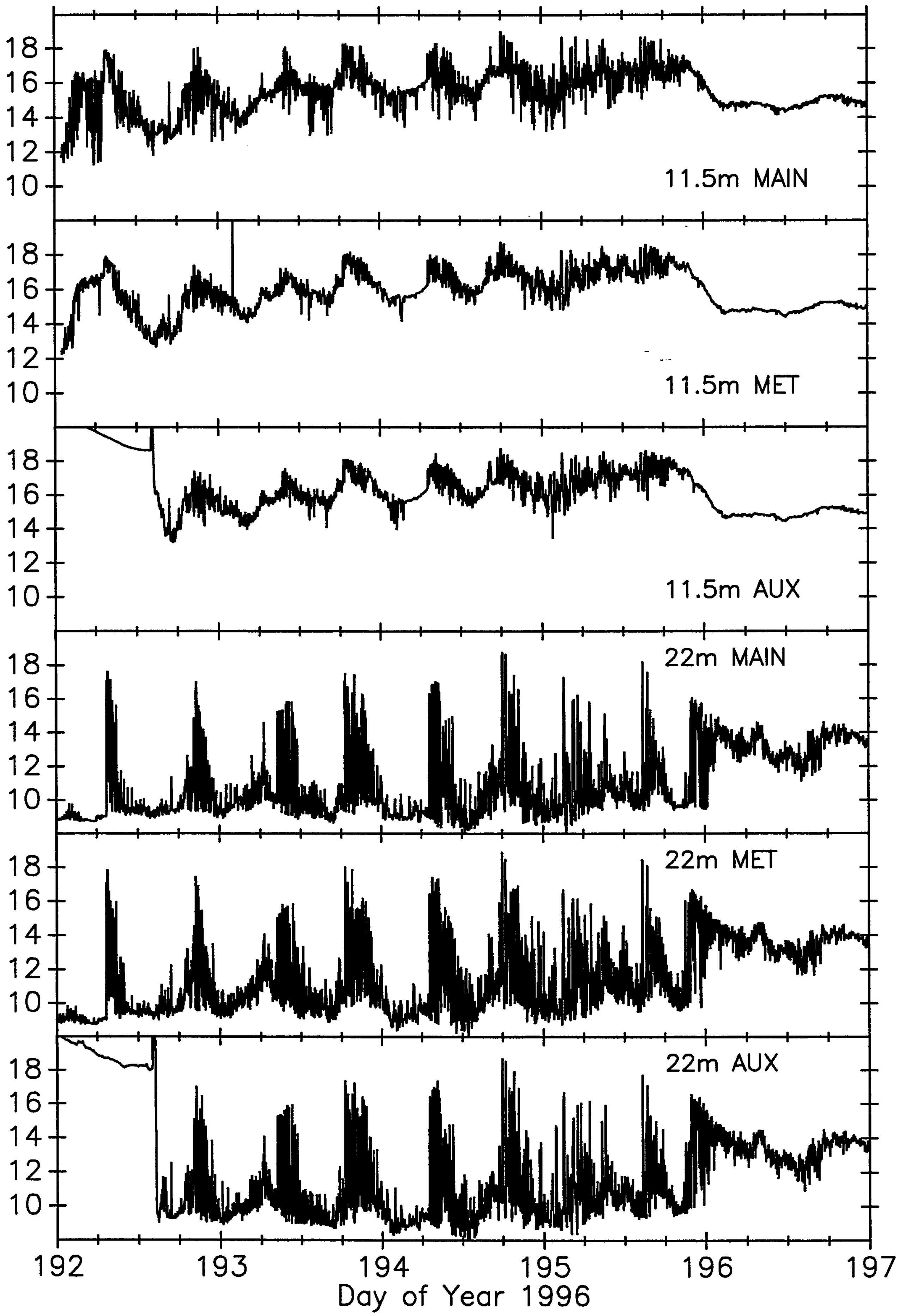
TEMPERATURE Time Series

Main, Met, and Aux Moorings: 11.5 m and 22 m

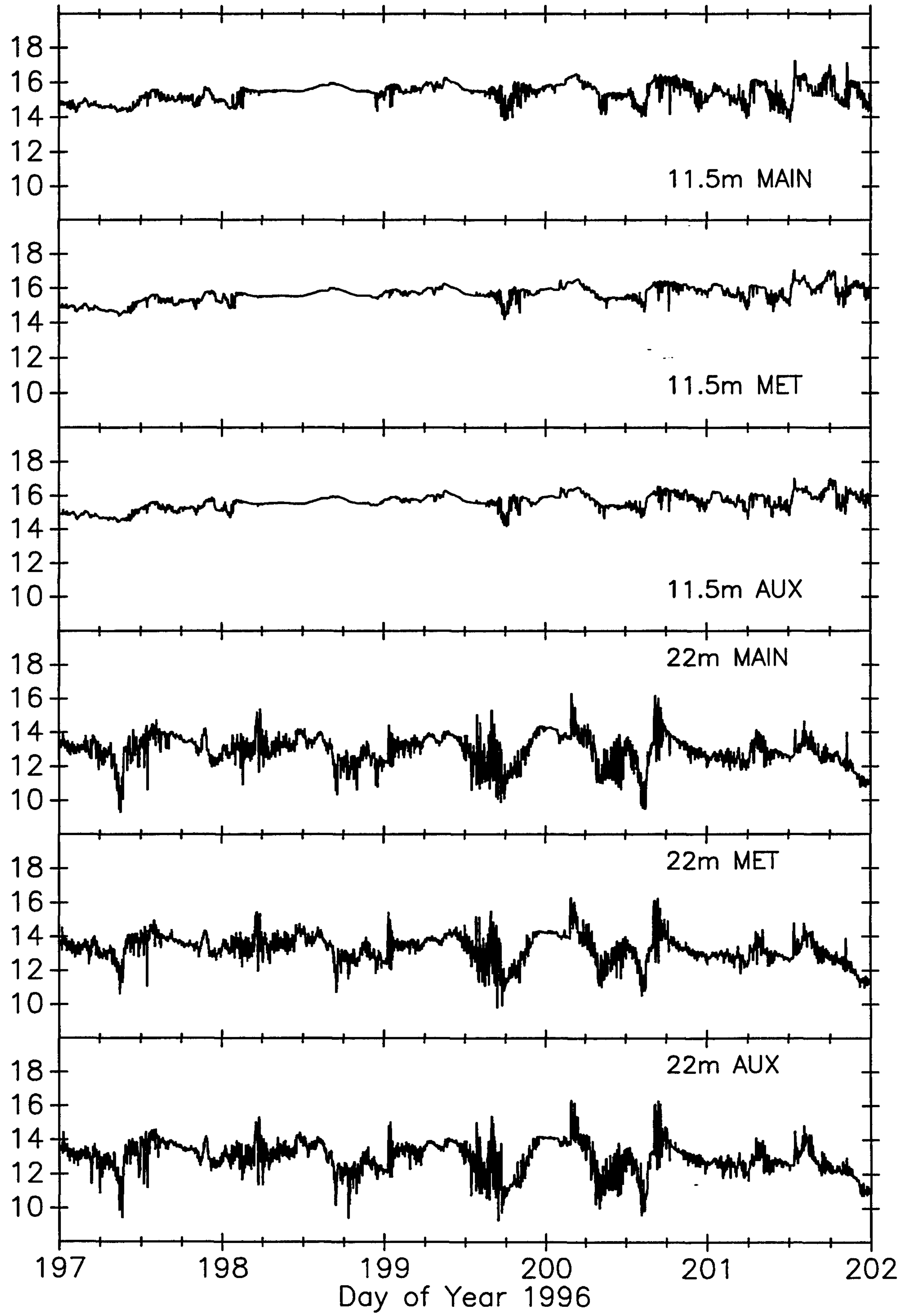
Unfiltered

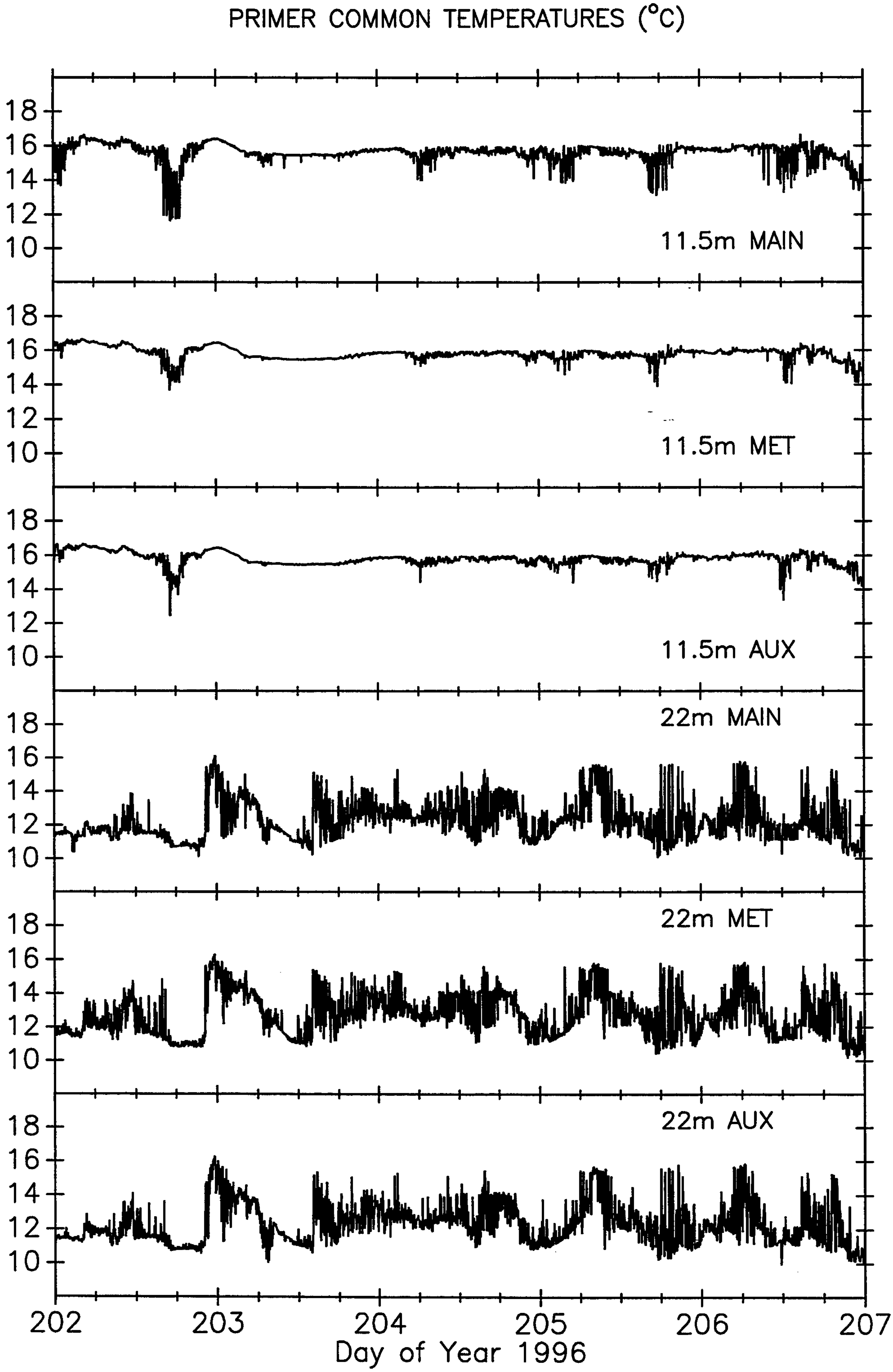
Temperature from instruments deployed at the same depths on the Main, Met, and Aux moorings: 11.5 m and 22 m. Consult Tables 1-3 for the instrument types and serial numbers. Temperatures are not filtered. Sampling rates are shown in Tables 1-3.

PRIMER COMMON TEMPERATURES (°C)

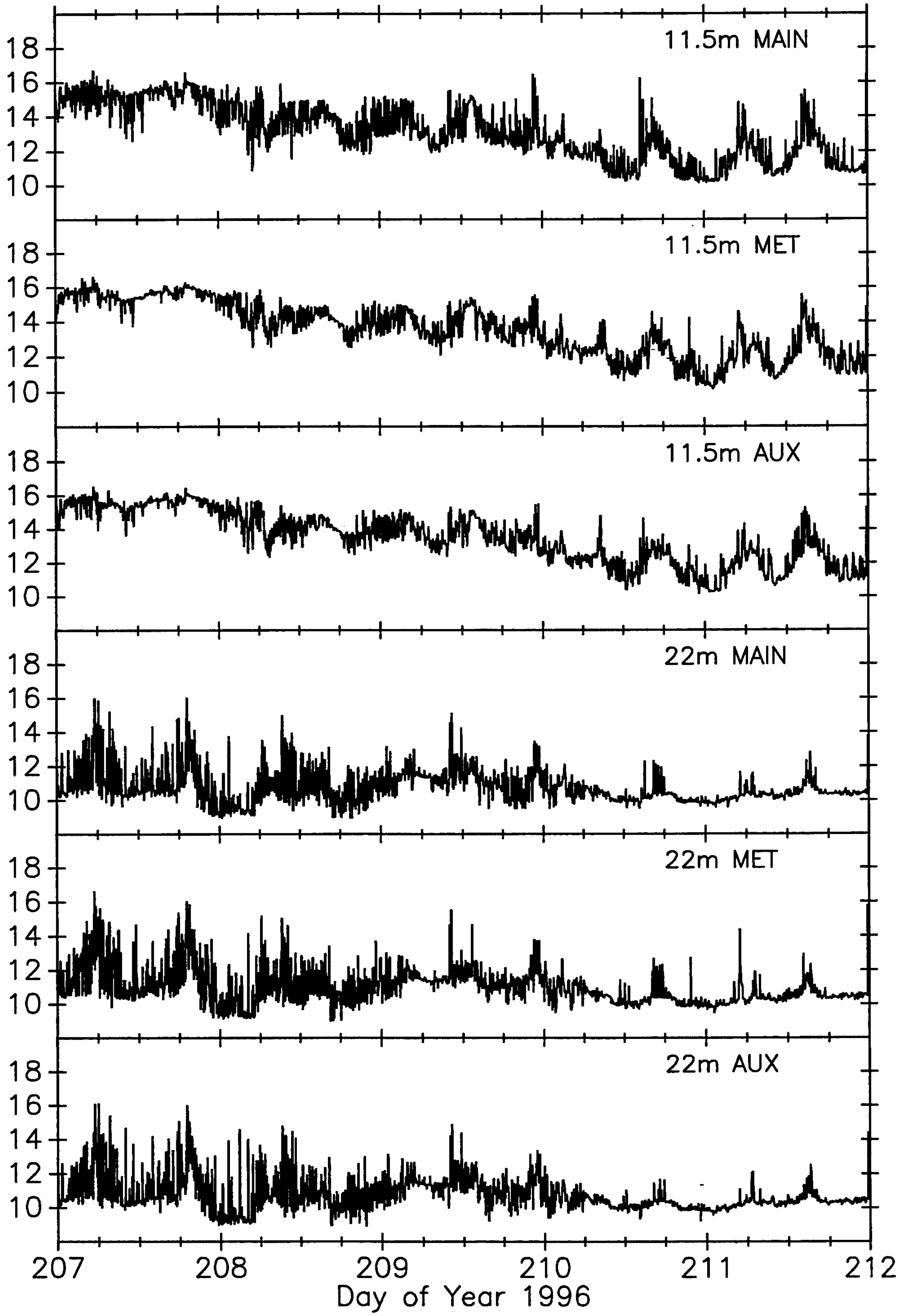


PRIMER COMMON TEMPERATURES (°C)

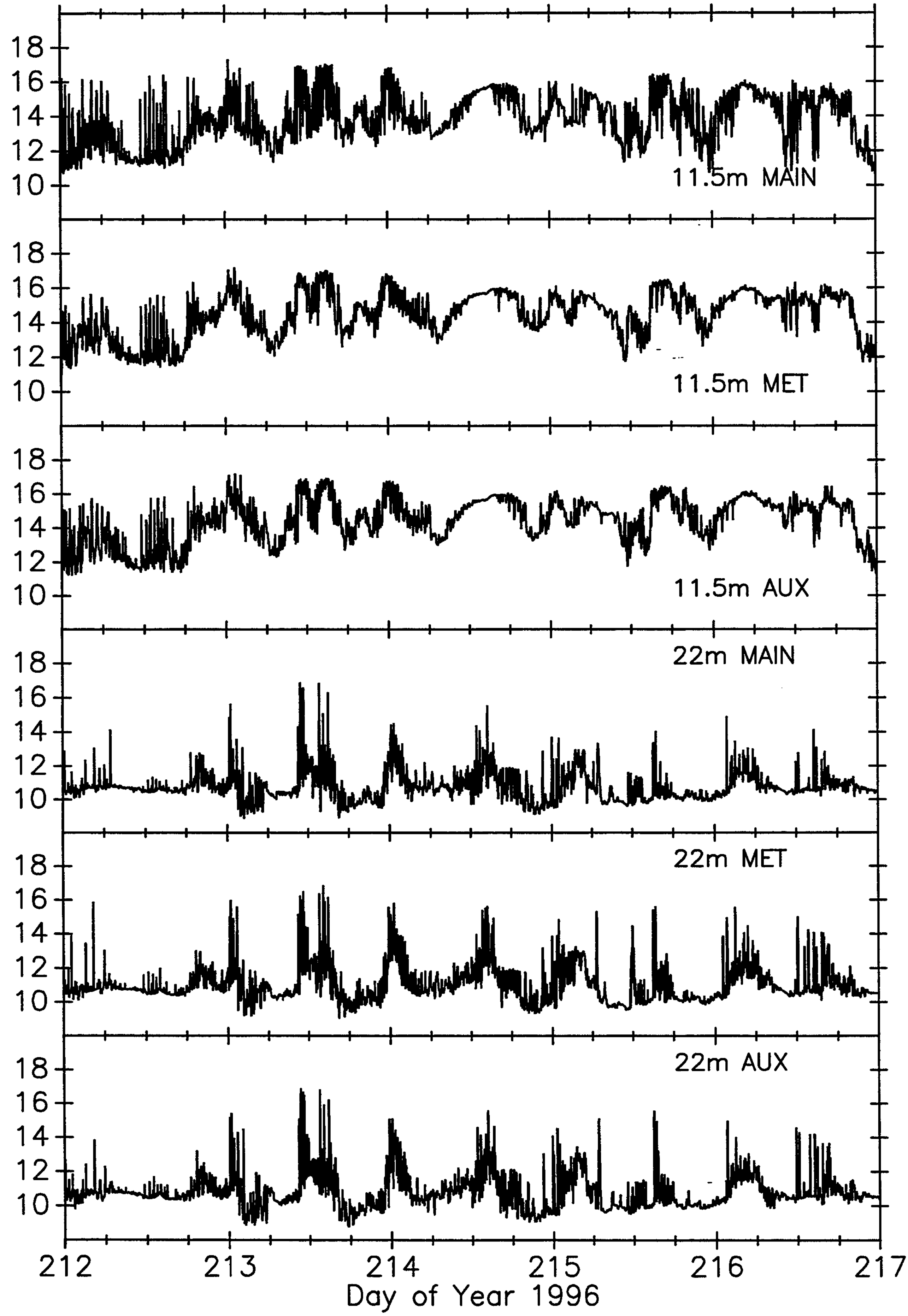


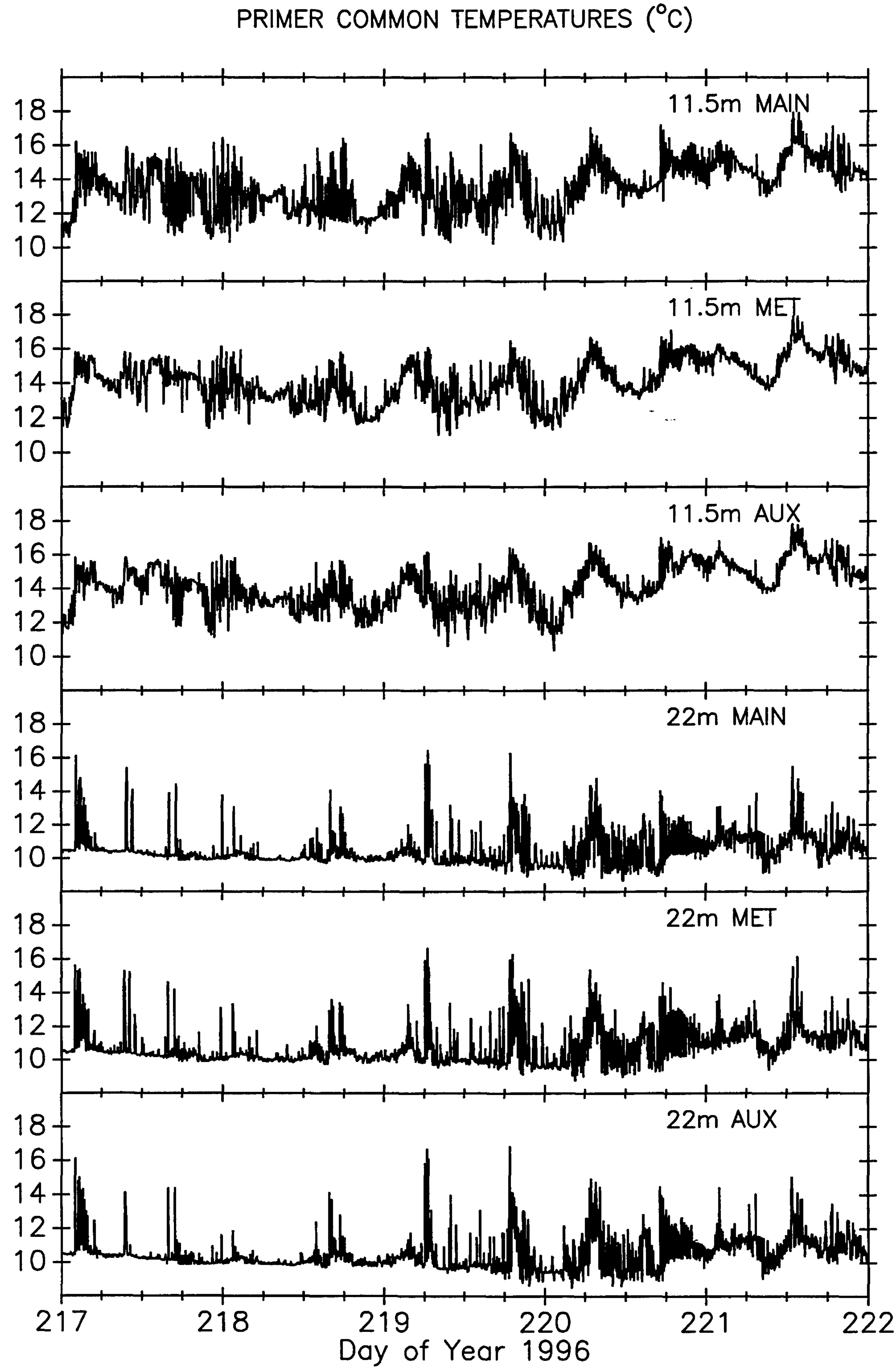

PRIMER COMMON TEMPERATURES (°C)
11.5m MAIN
11.5m MET
11.5m AUX
22m MAIN
22m MET
22m AUX
18
16
14
12
10
202
203
204
205
206
207
Day of Year 1996

PRIMER COMMON TEMPERATURES (°C)

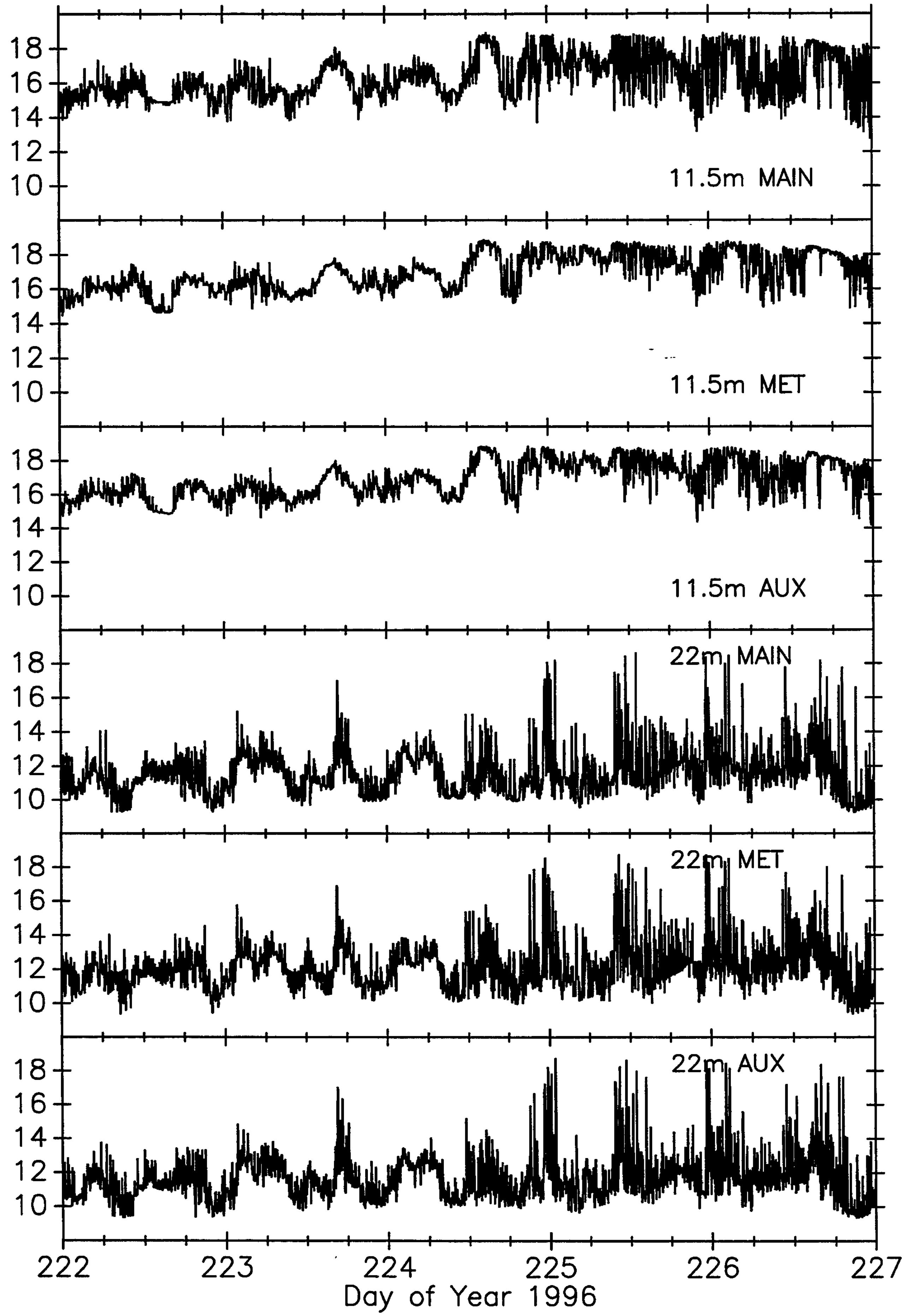


PRIMER COMMON TEMPERATURES (°C)

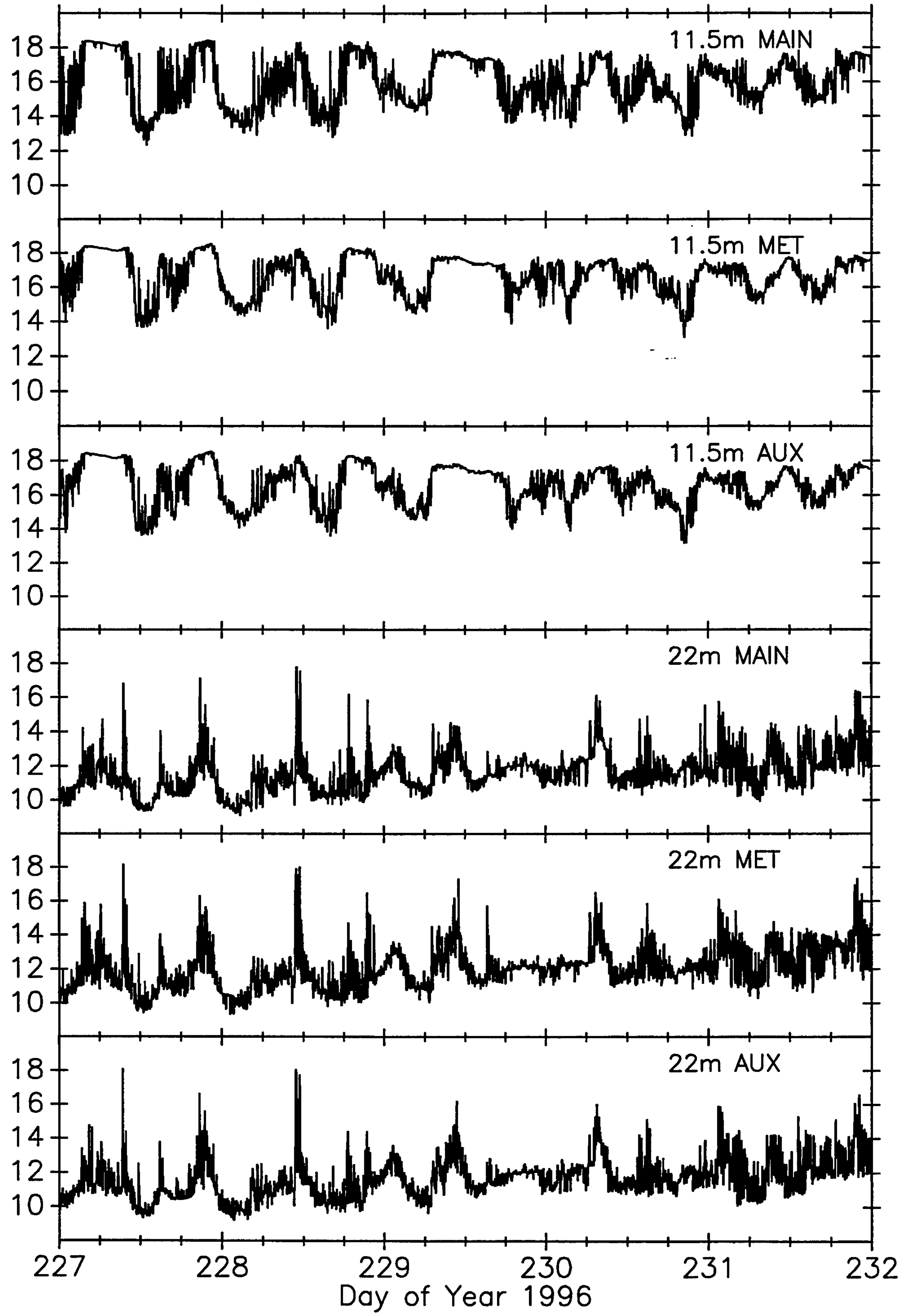



PRIMER COMMON TEMPERATURES (°C)
11.5m MAIN
11.5m MET
11.5m AUX
22m MAIN
22m MET
22m AUX
18
16
14
12
10
217
218
219
220
221
222
Day of Year 1996

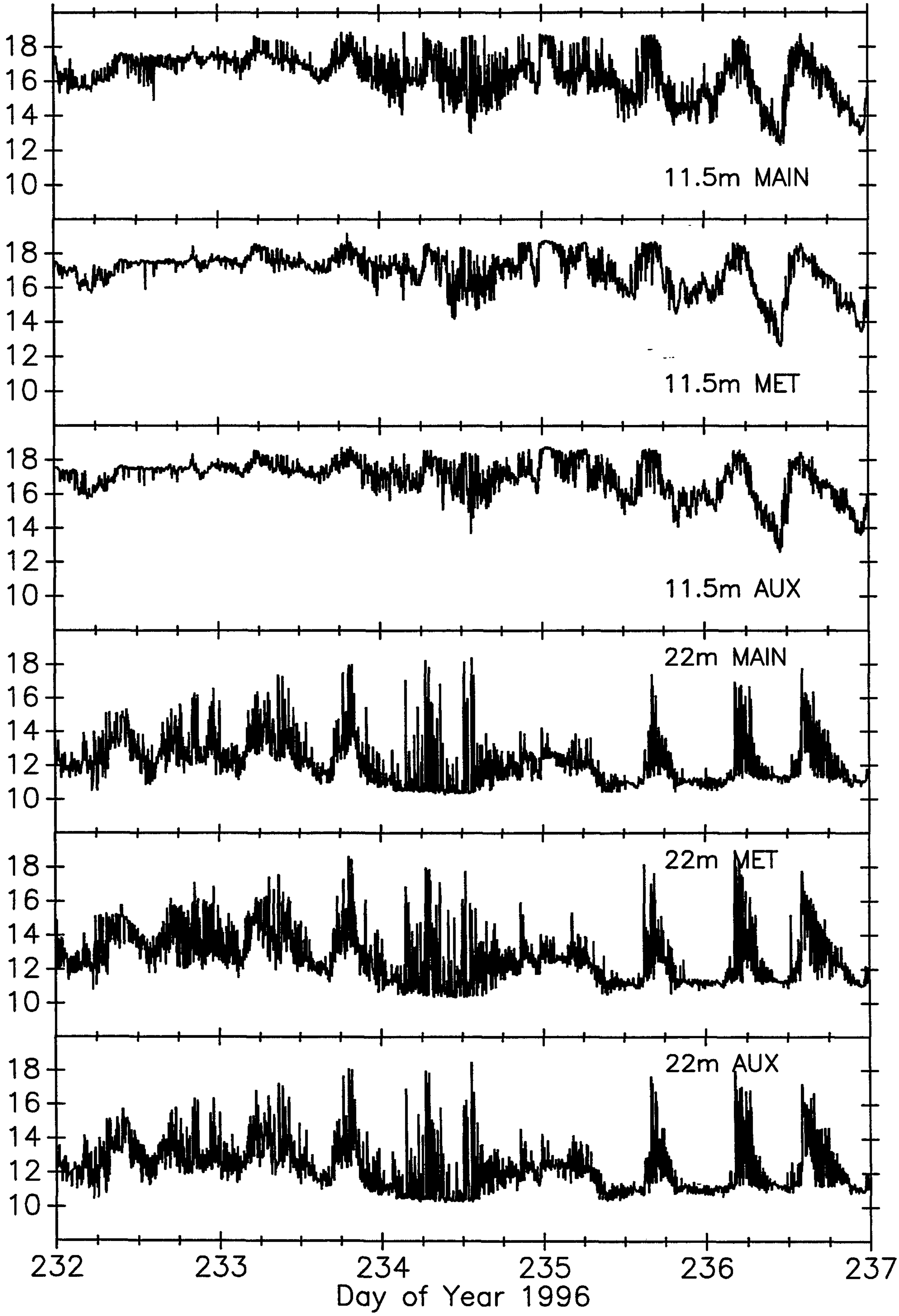
PRIMER COMMON TEMPERATURES (°C)



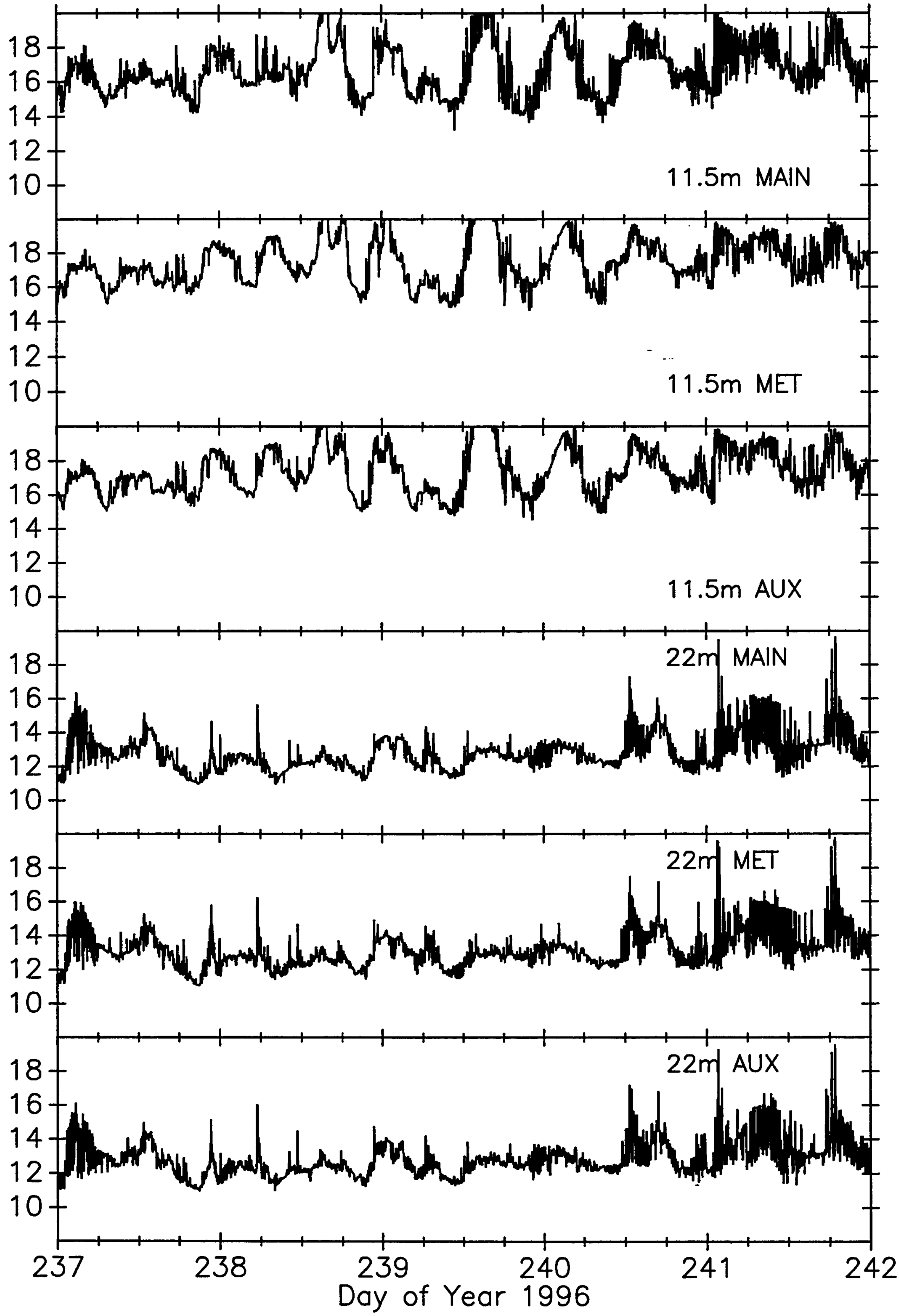
PRIMER COMMON TEMPERATURES (°C)



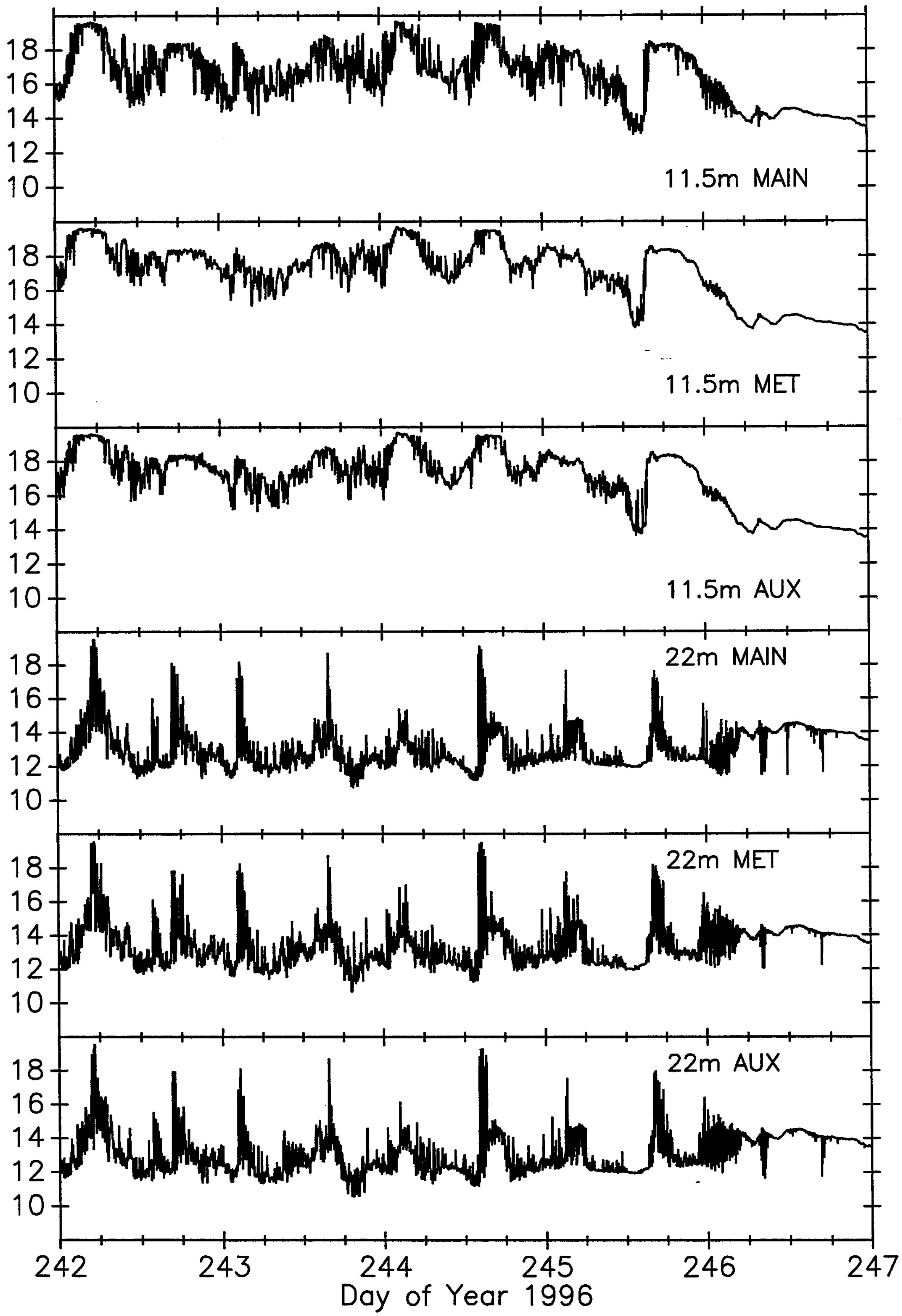
PRIMER COMMON TEMPERATURES (°C)



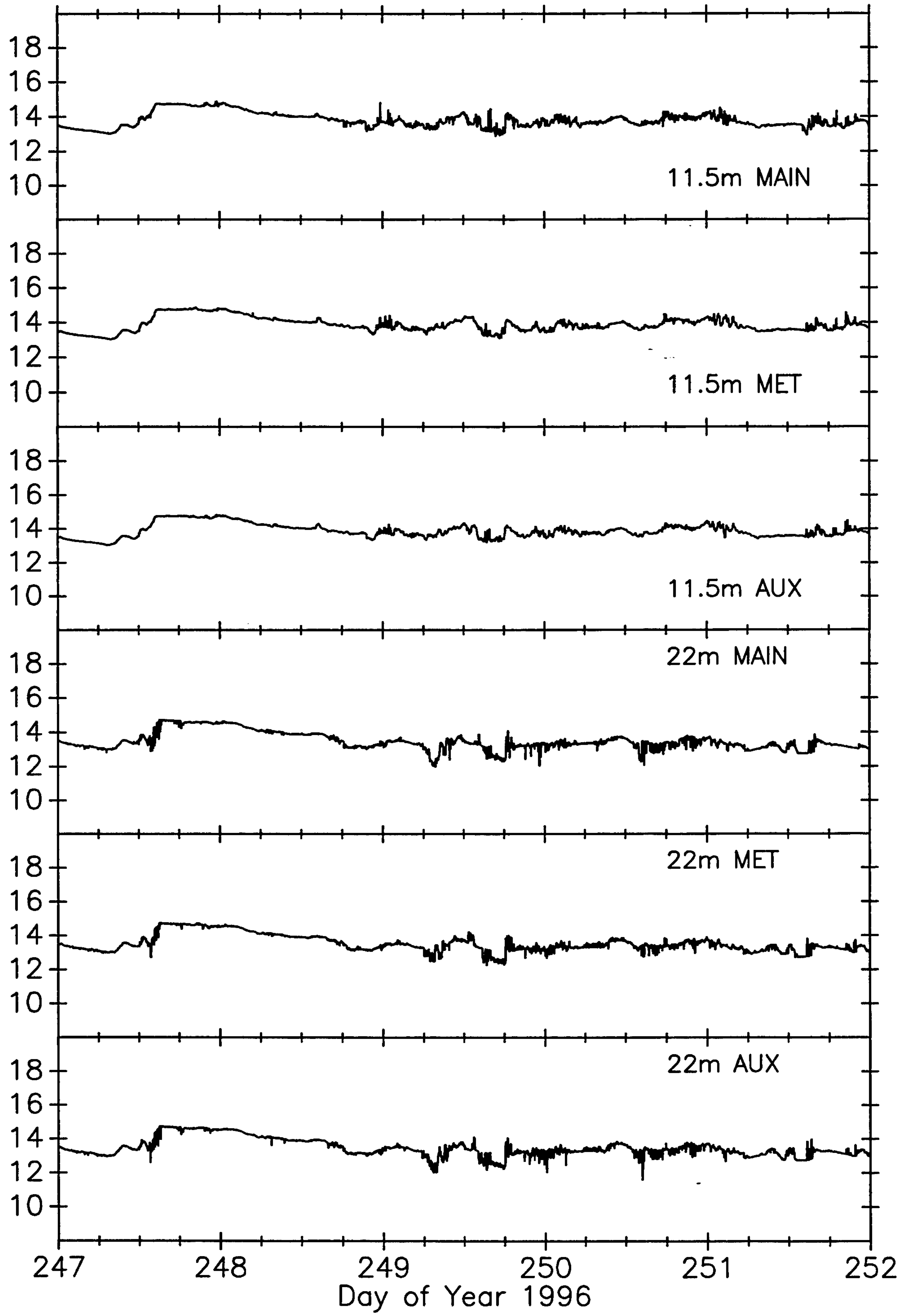
PRIMER COMMON TEMPERATURES (°C)



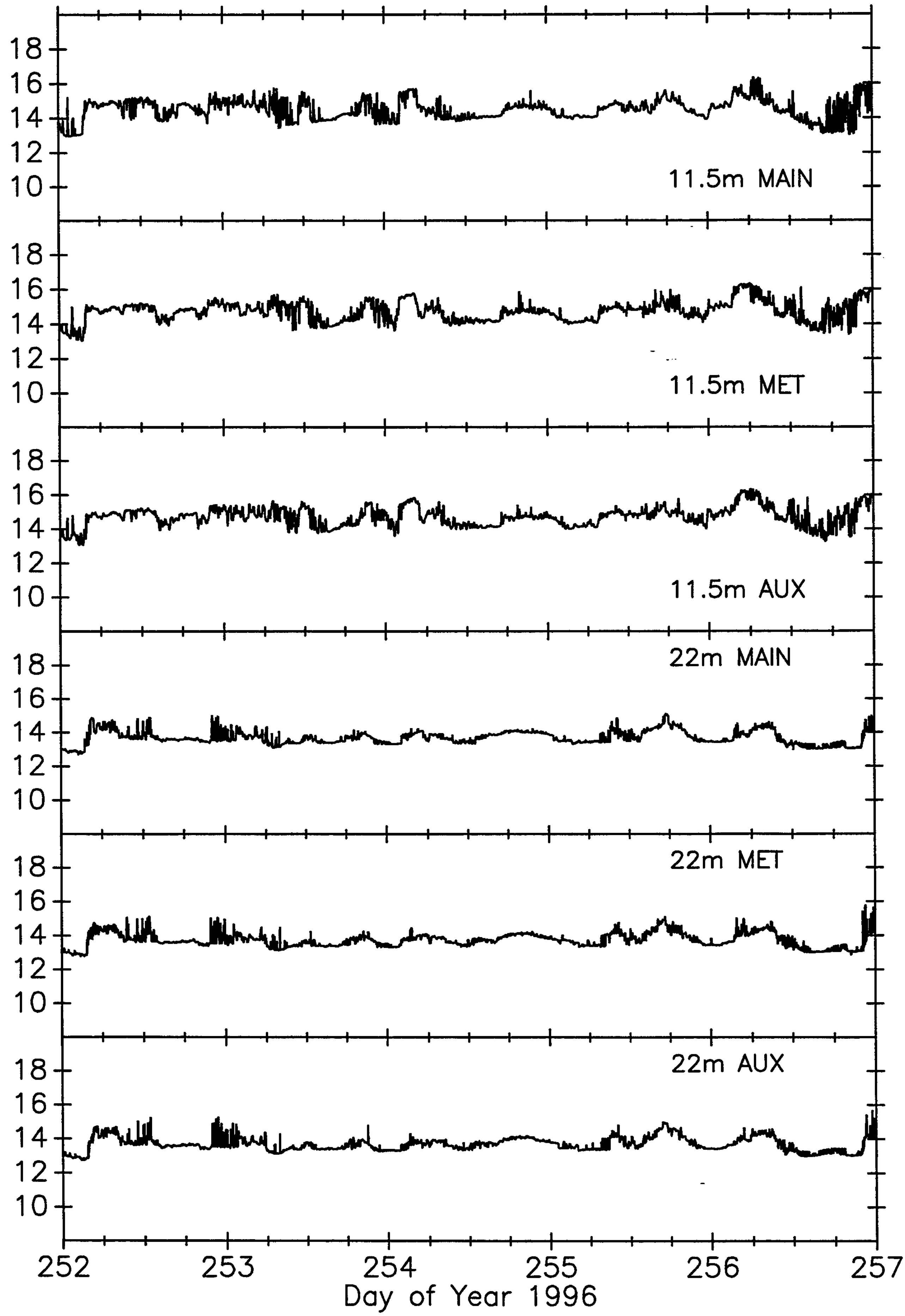
PRIMER COMMON TEMPERATURES (°C)



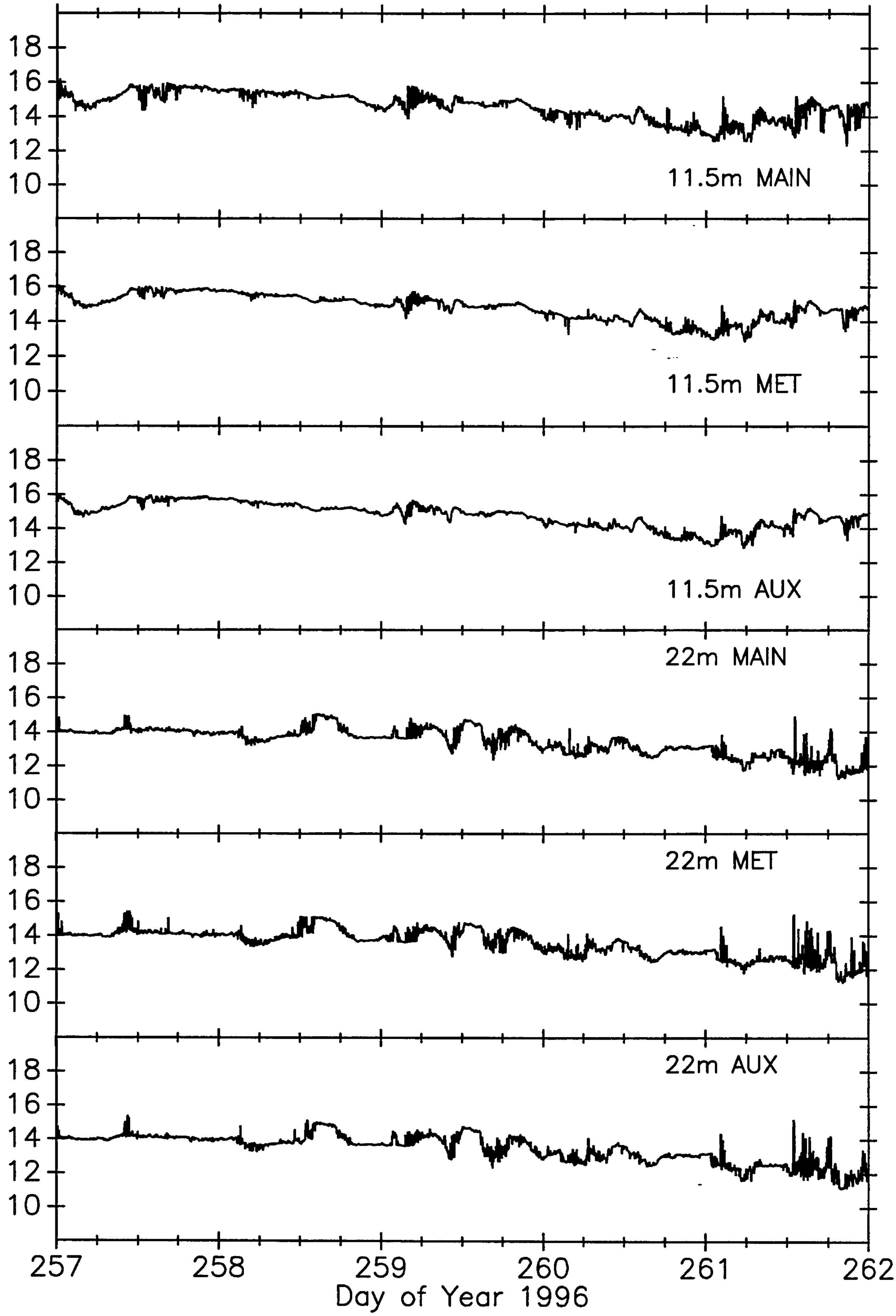
PRIMER COMMON TEMPERATURES (°C)



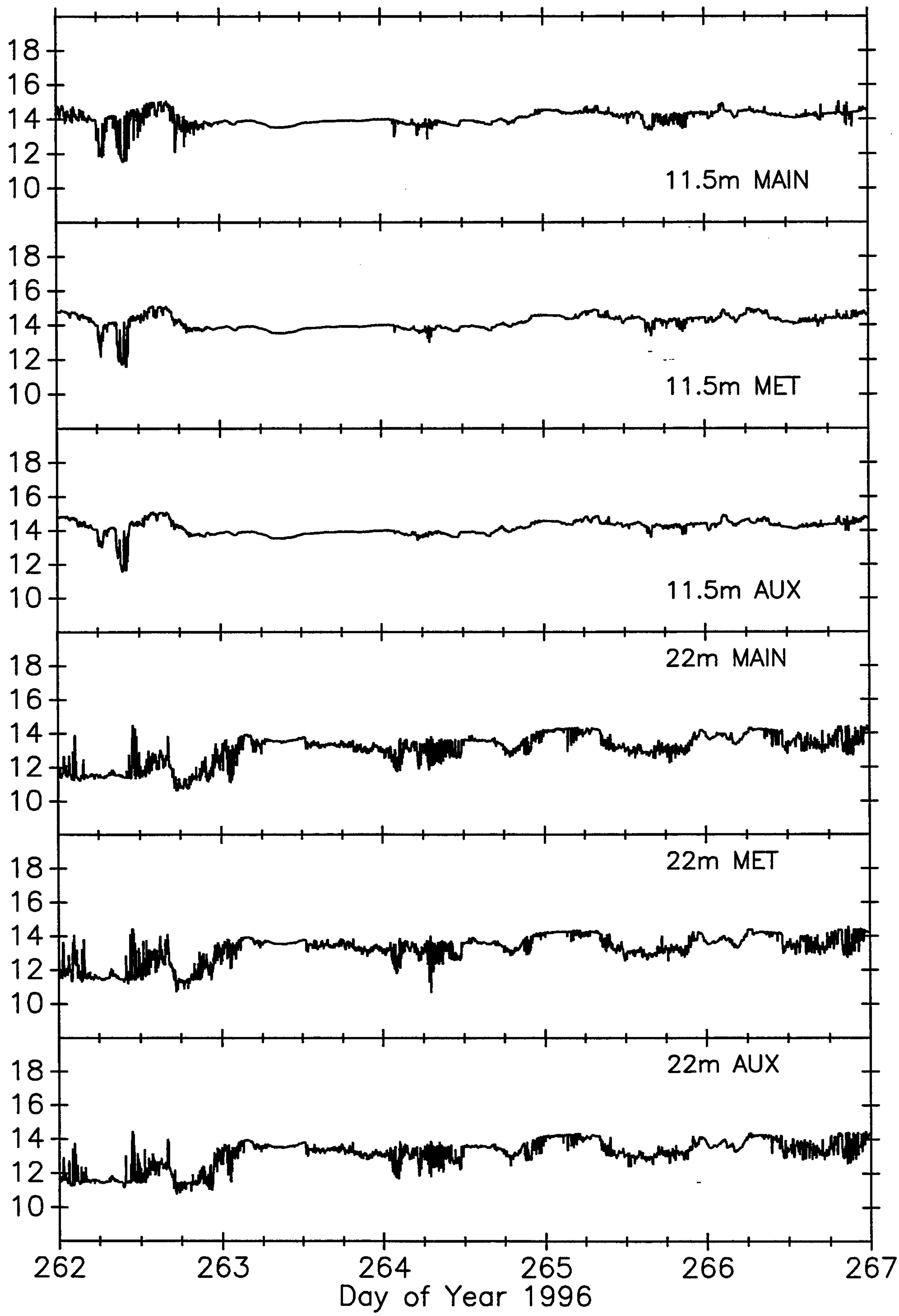
PRIMER COMMON TEMPERATURES (°C)



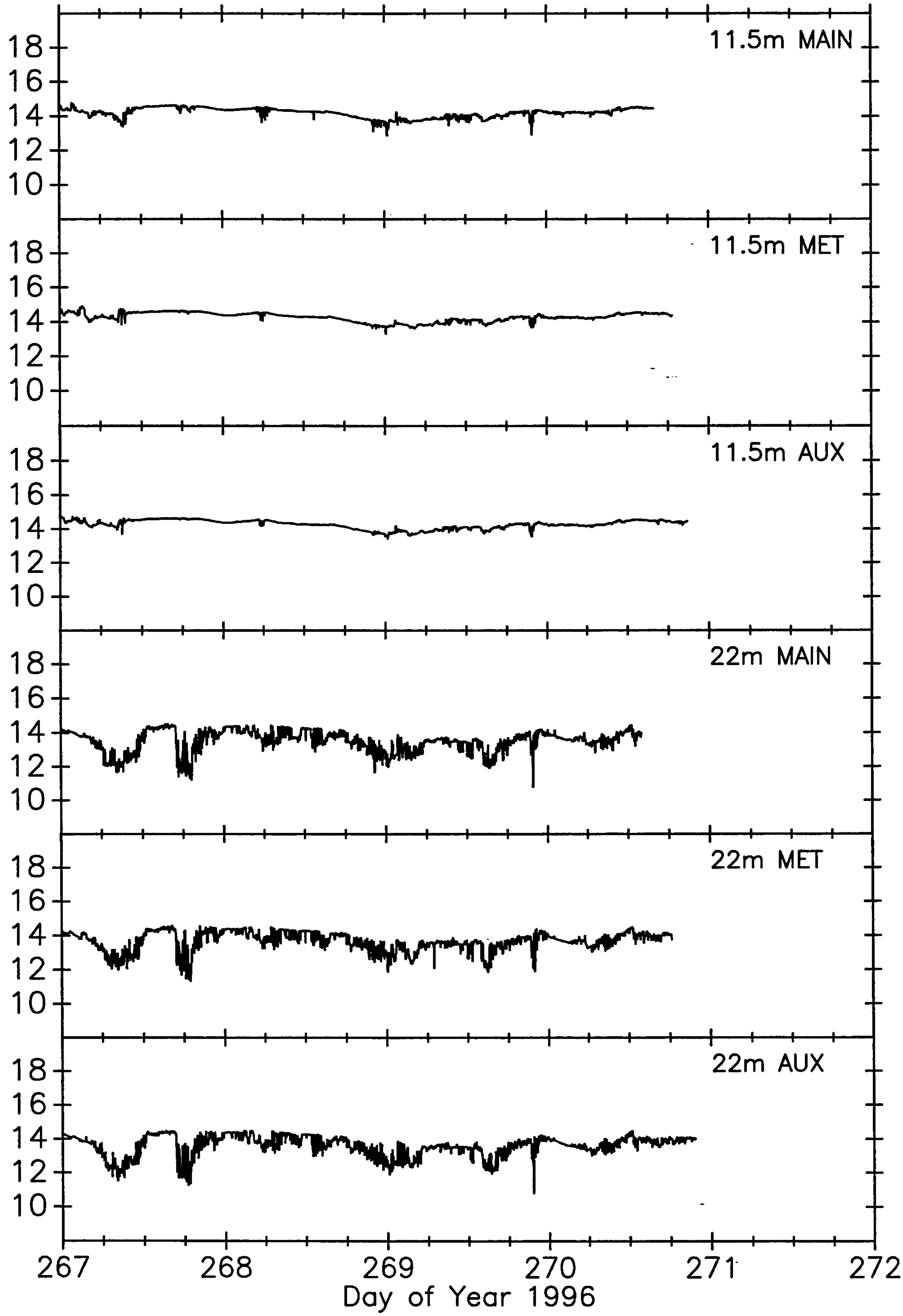
PRIMER COMMON TEMPERATURES (°C)



PRIMER COMMON TEMPERATURES (°C)



PRIMER COMMON TEMPERATURES (°C)



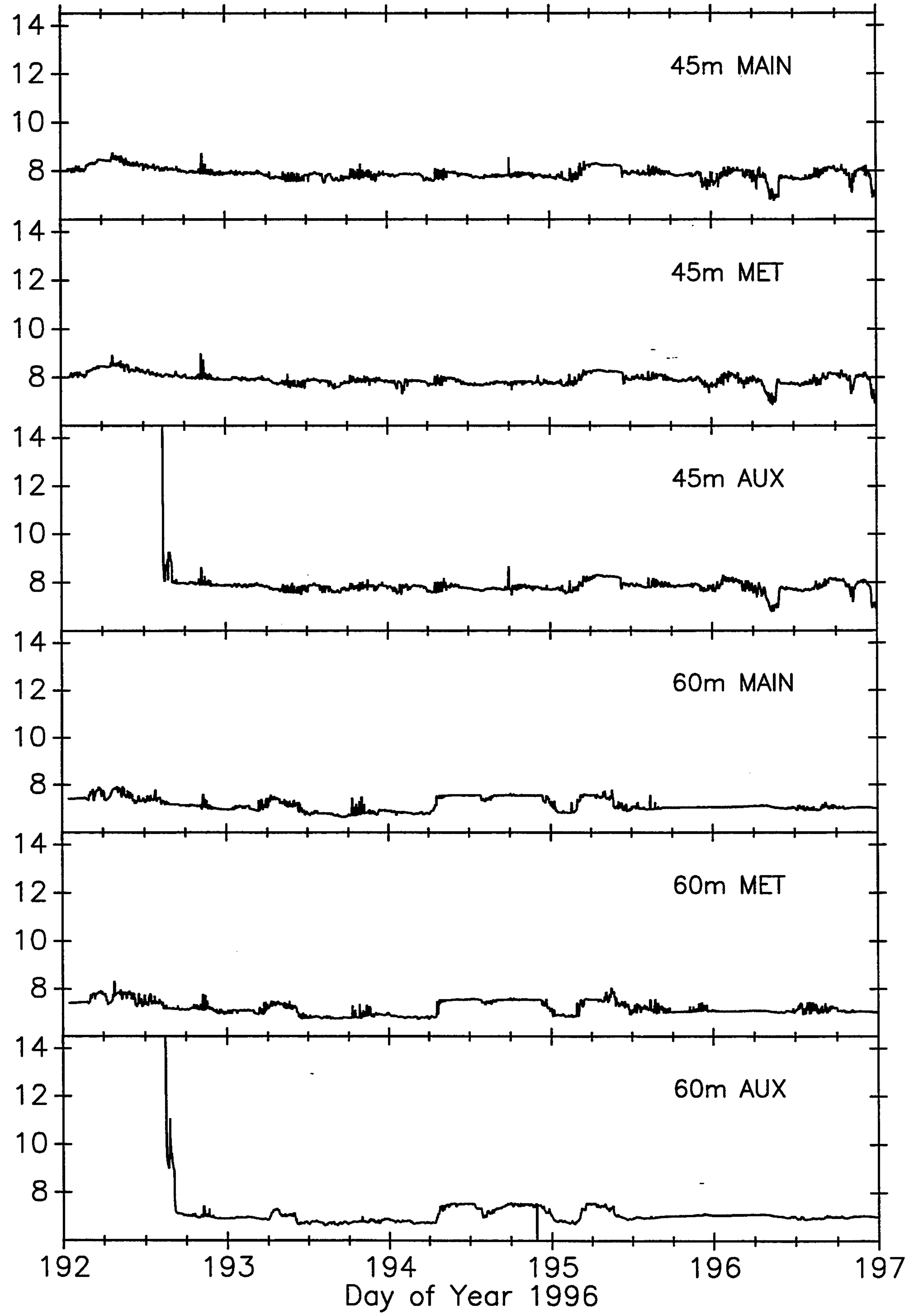
TEMPERATURE Time Series

Main, Met, and Aux Moorings: 45 m and 60 m

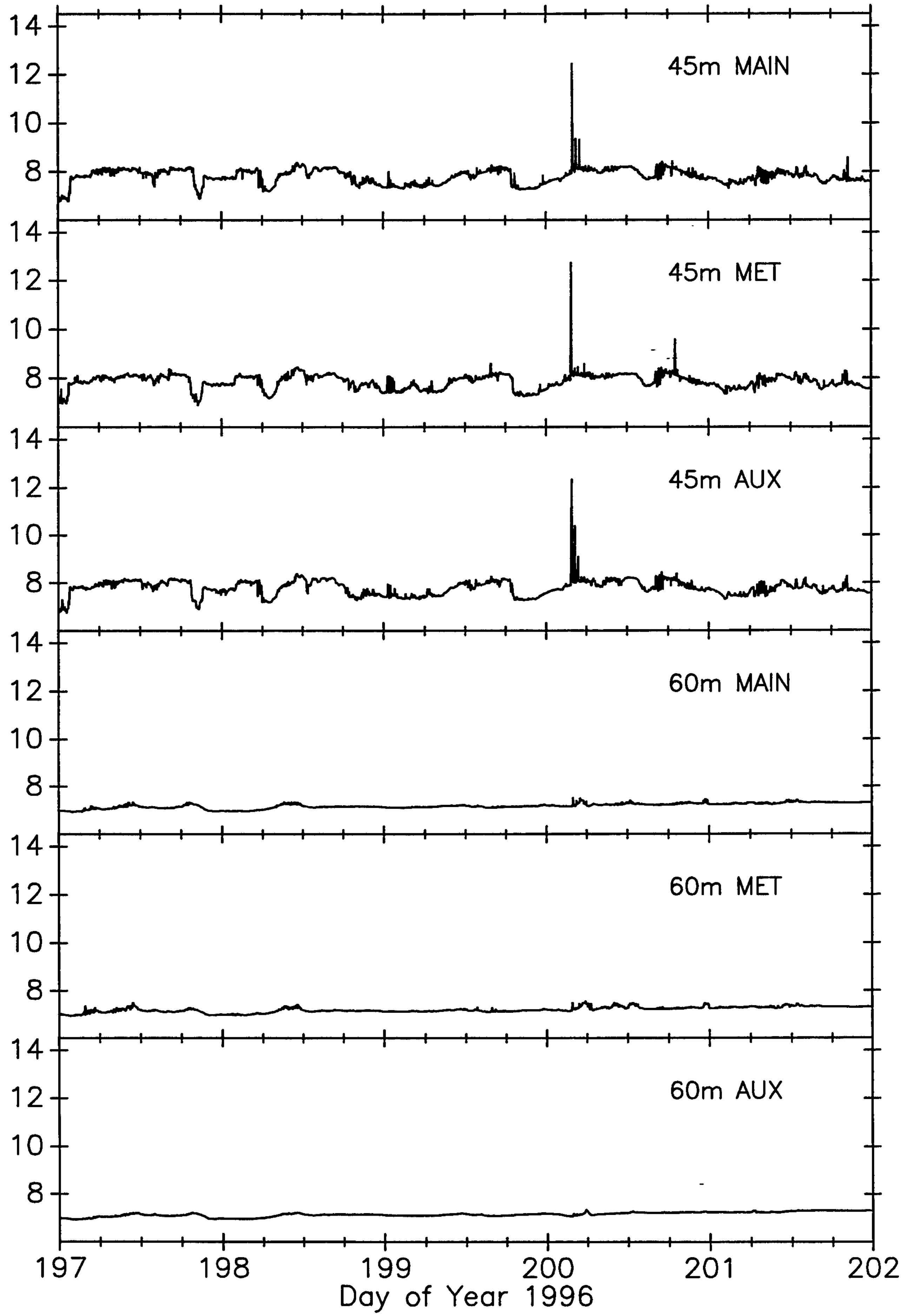
Unfiltered

Temperature from instruments deployed at the same depths on the Main, Met, and Aux moorings: 45 m and 60 m. Consult Tables 1-3 for the instrument types and serial numbers. Temperatures are not filtered. Sampling rates are shown in Tables 1-3.

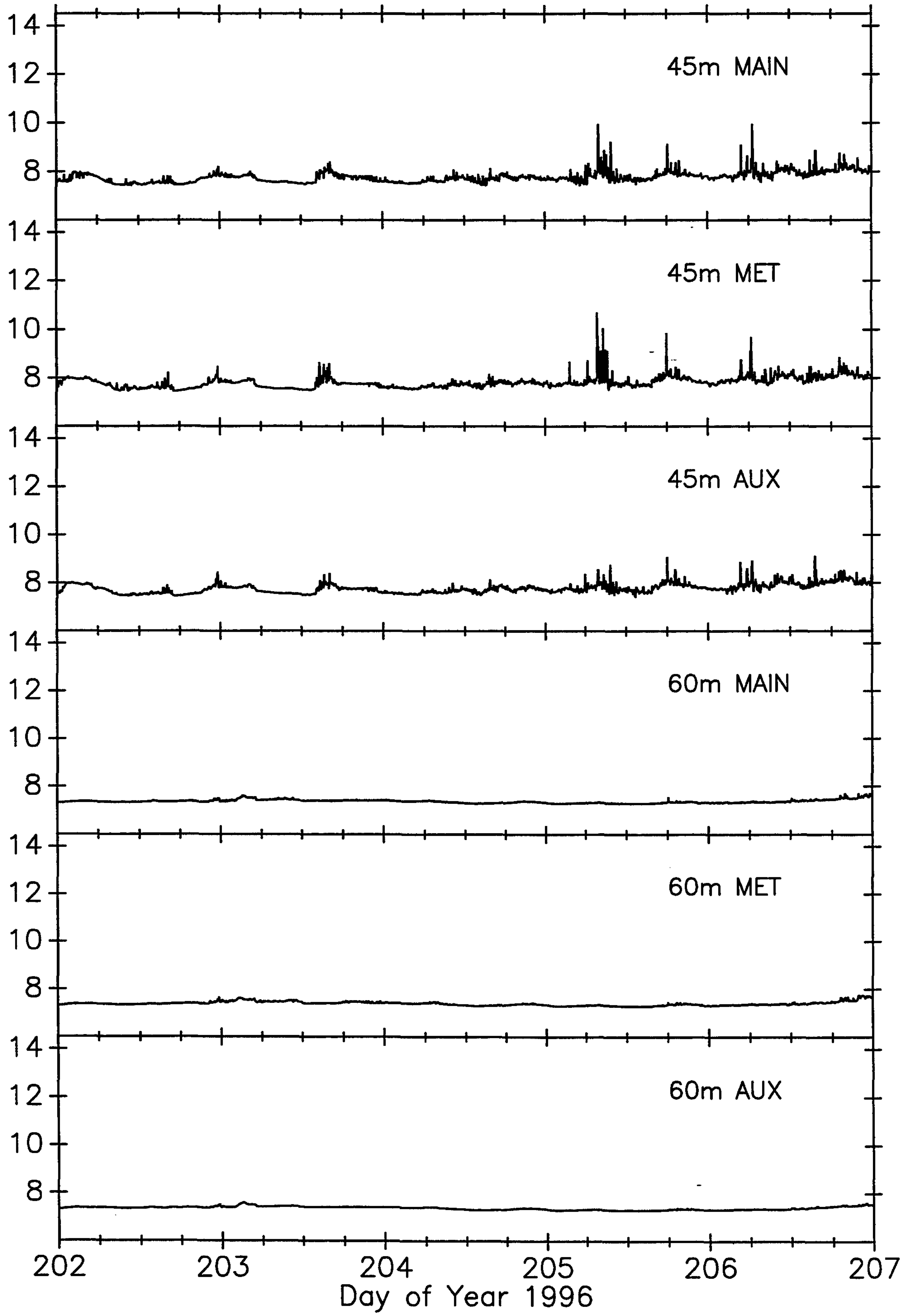
PRIMER COMMON TEMPERATURES (°C)



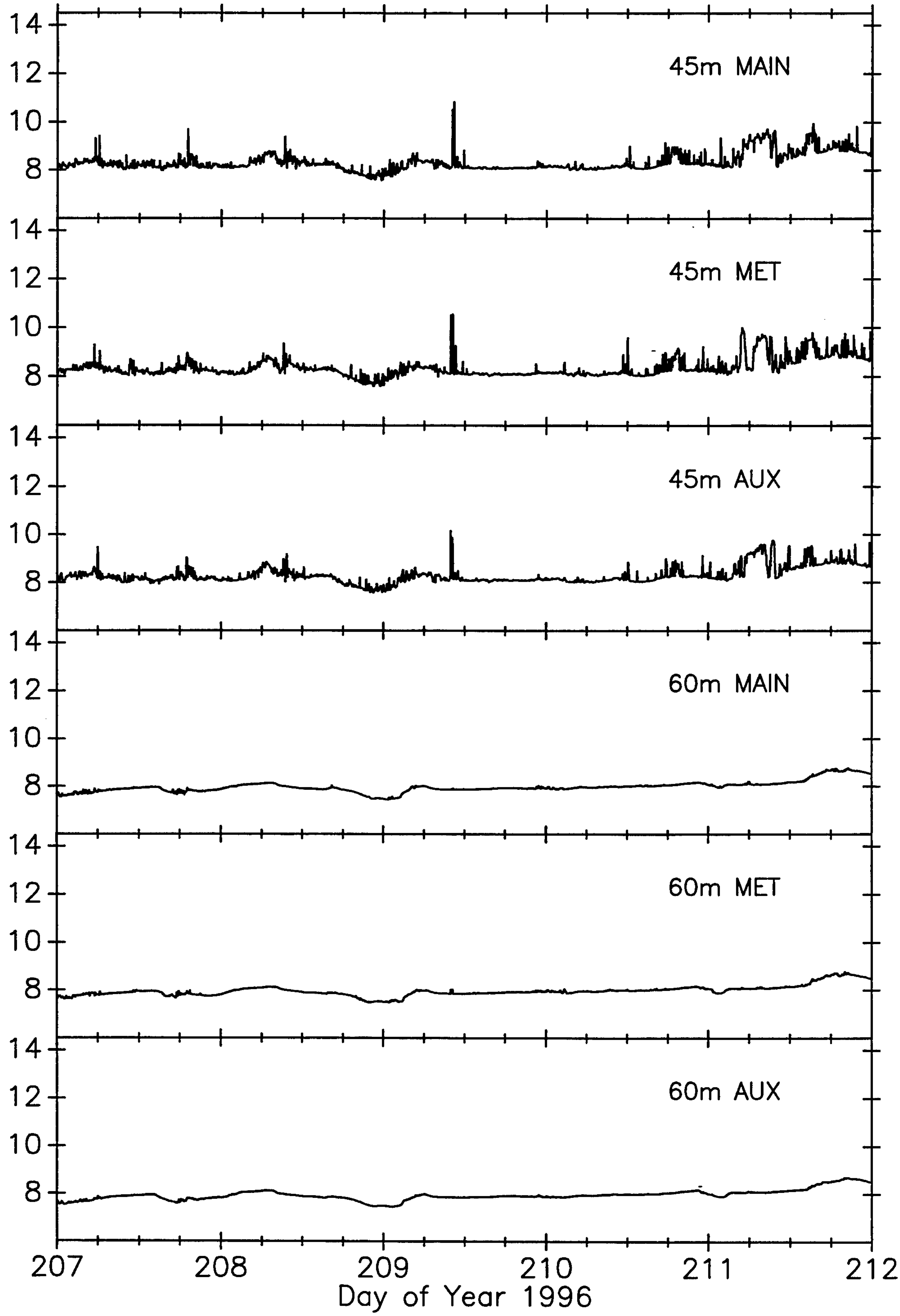
PRIMER COMMON TEMPERATURES (°C)



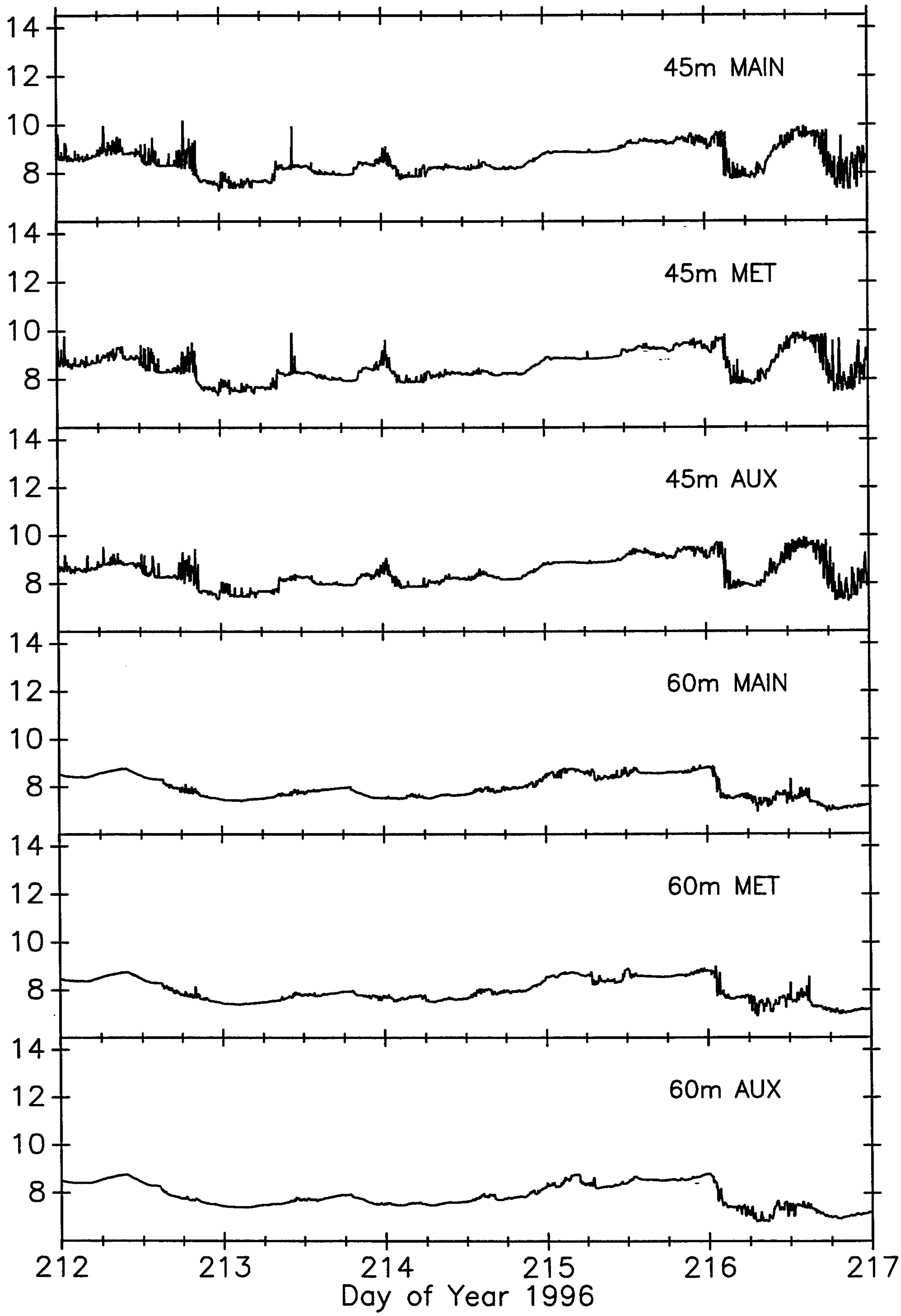
PRIMER COMMON TEMPERATURES (°C)

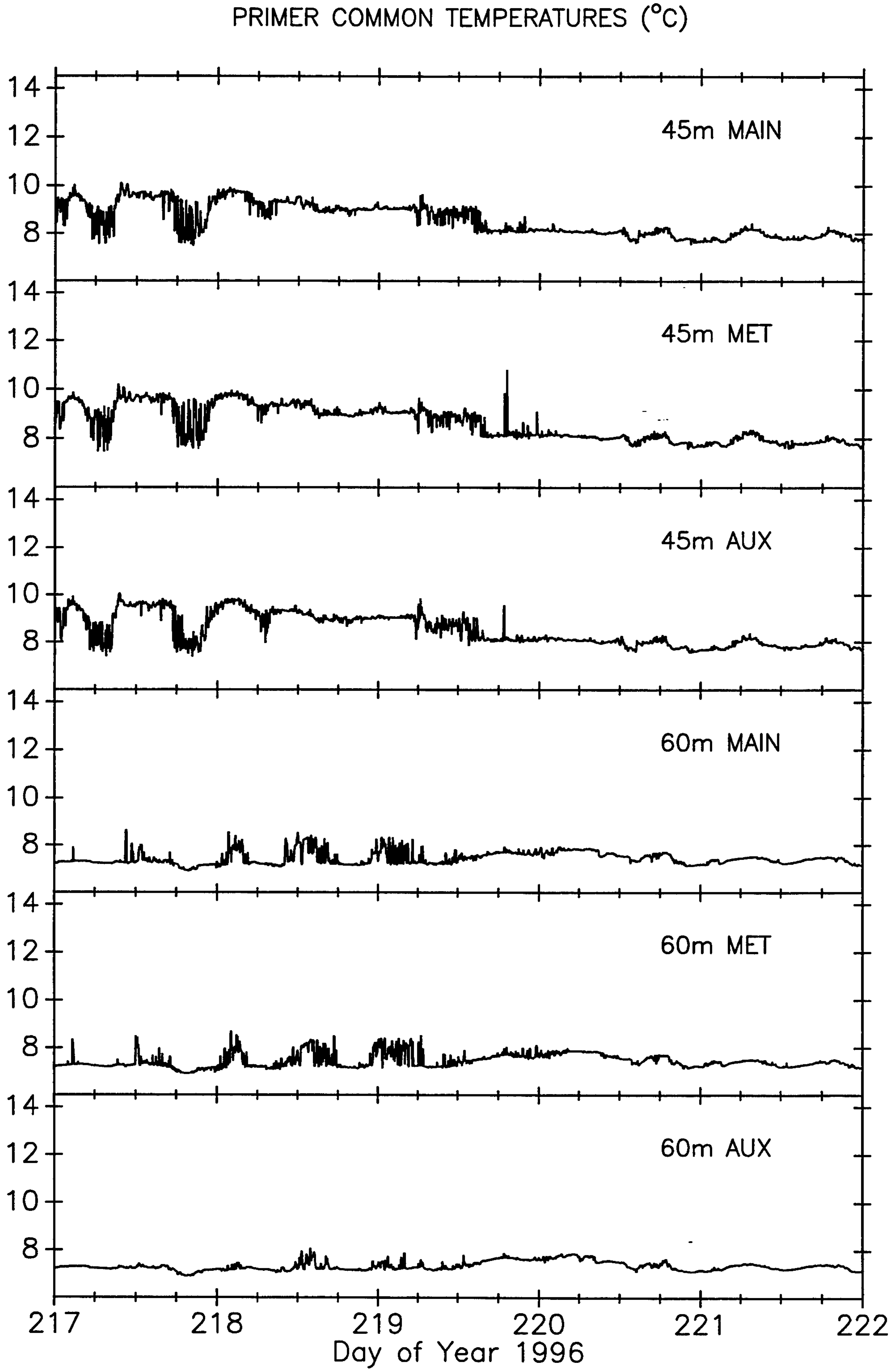


PRIMER COMMON TEMPERATURES (°C)

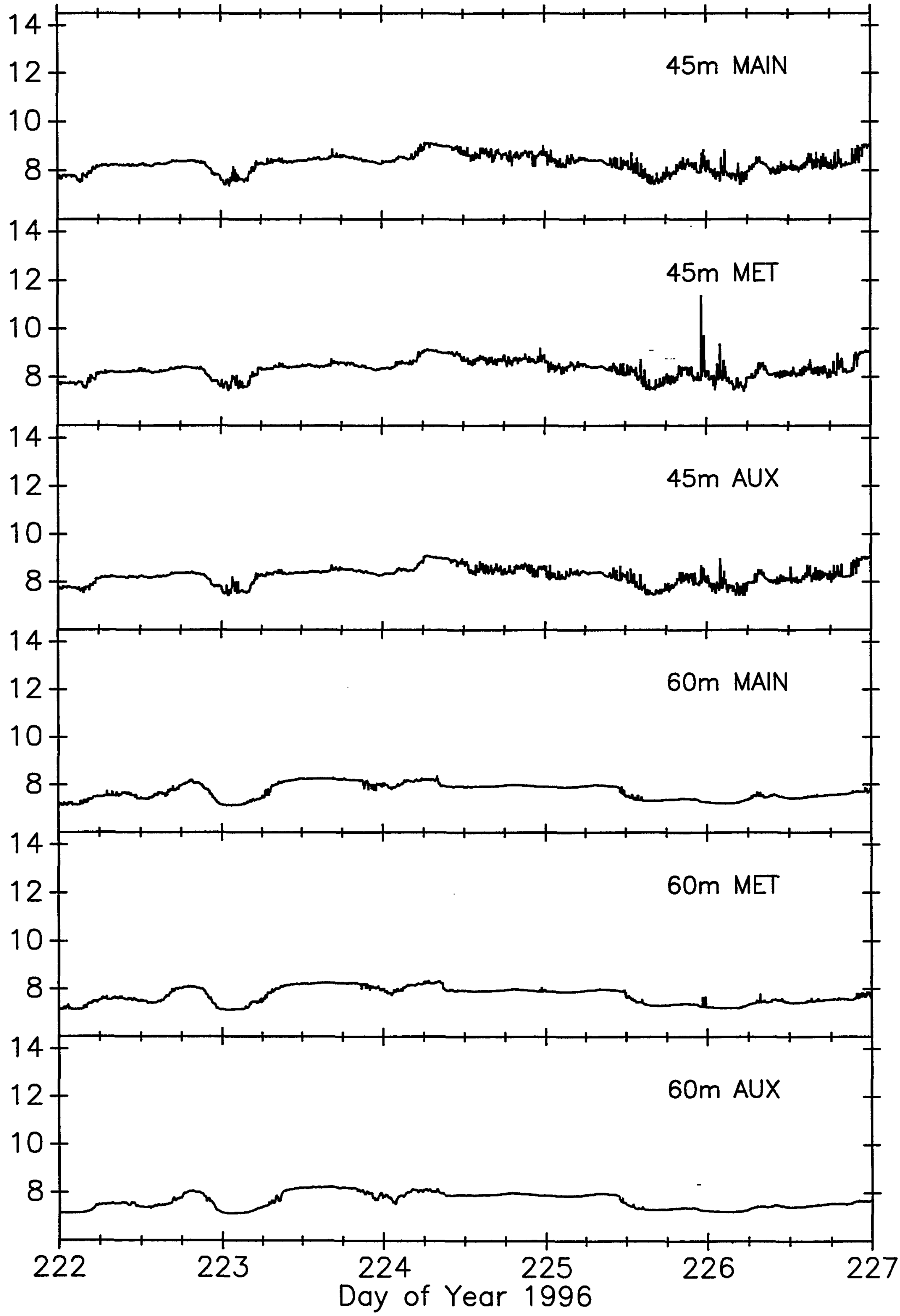


PRIMER COMMON TEMPERATURES (°C)

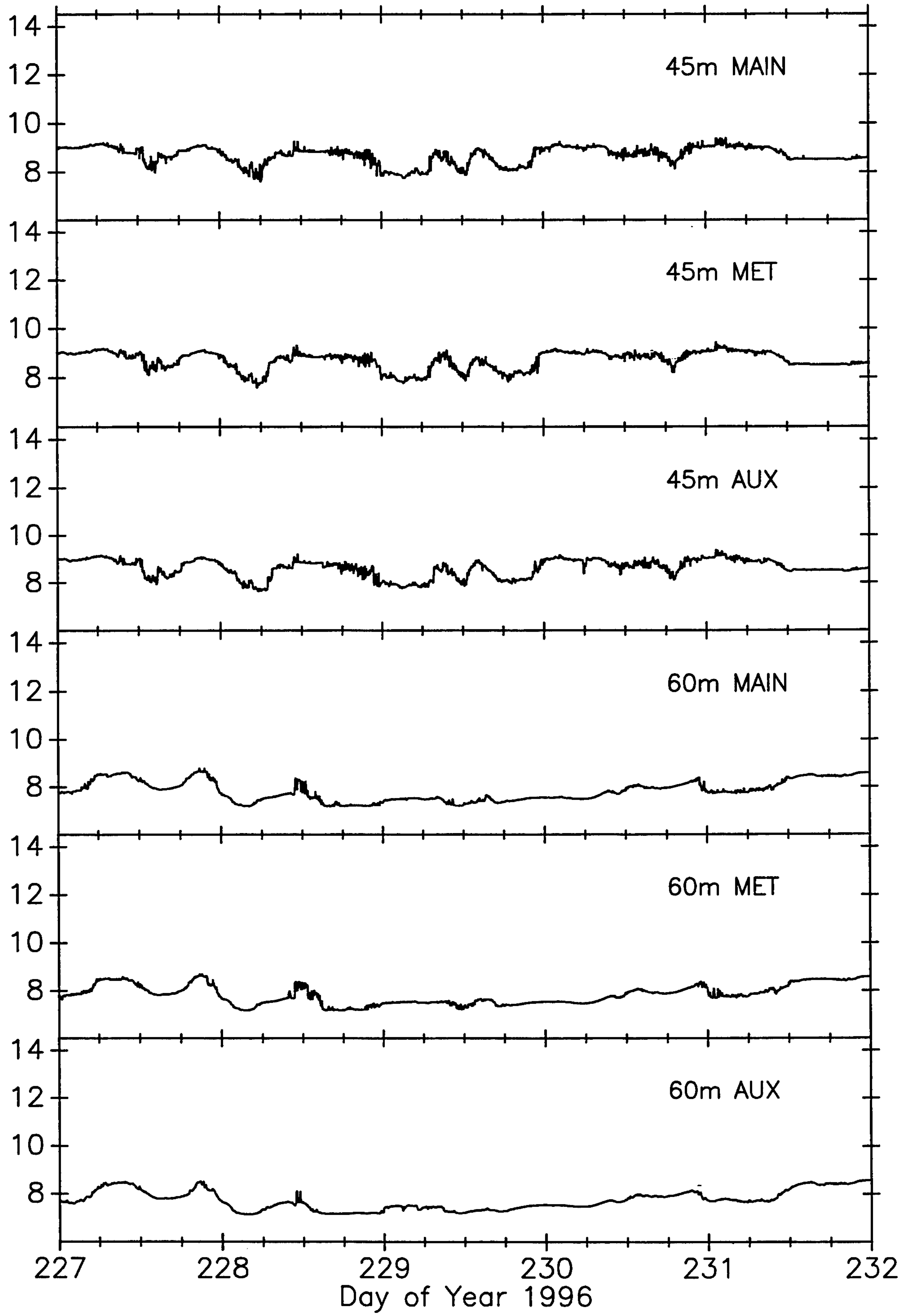


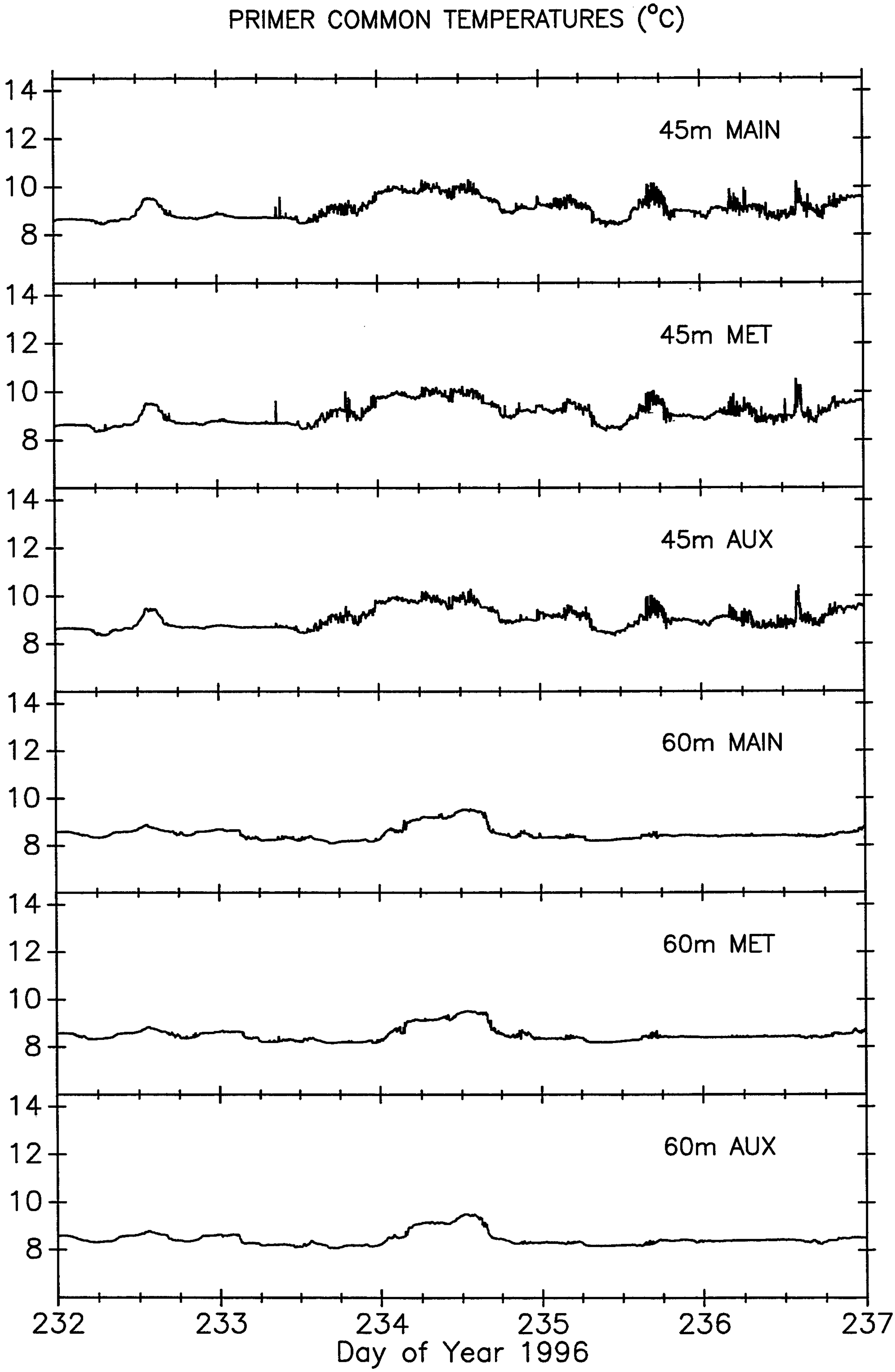

PRIMER COMMON TEMPERATURES (°C)
45m MAIN
45m MET
45m AUX
60m MAIN
60m MET
60m AUX
14
12
10
8
217
218
219
220
221
222
Day of Year 1996

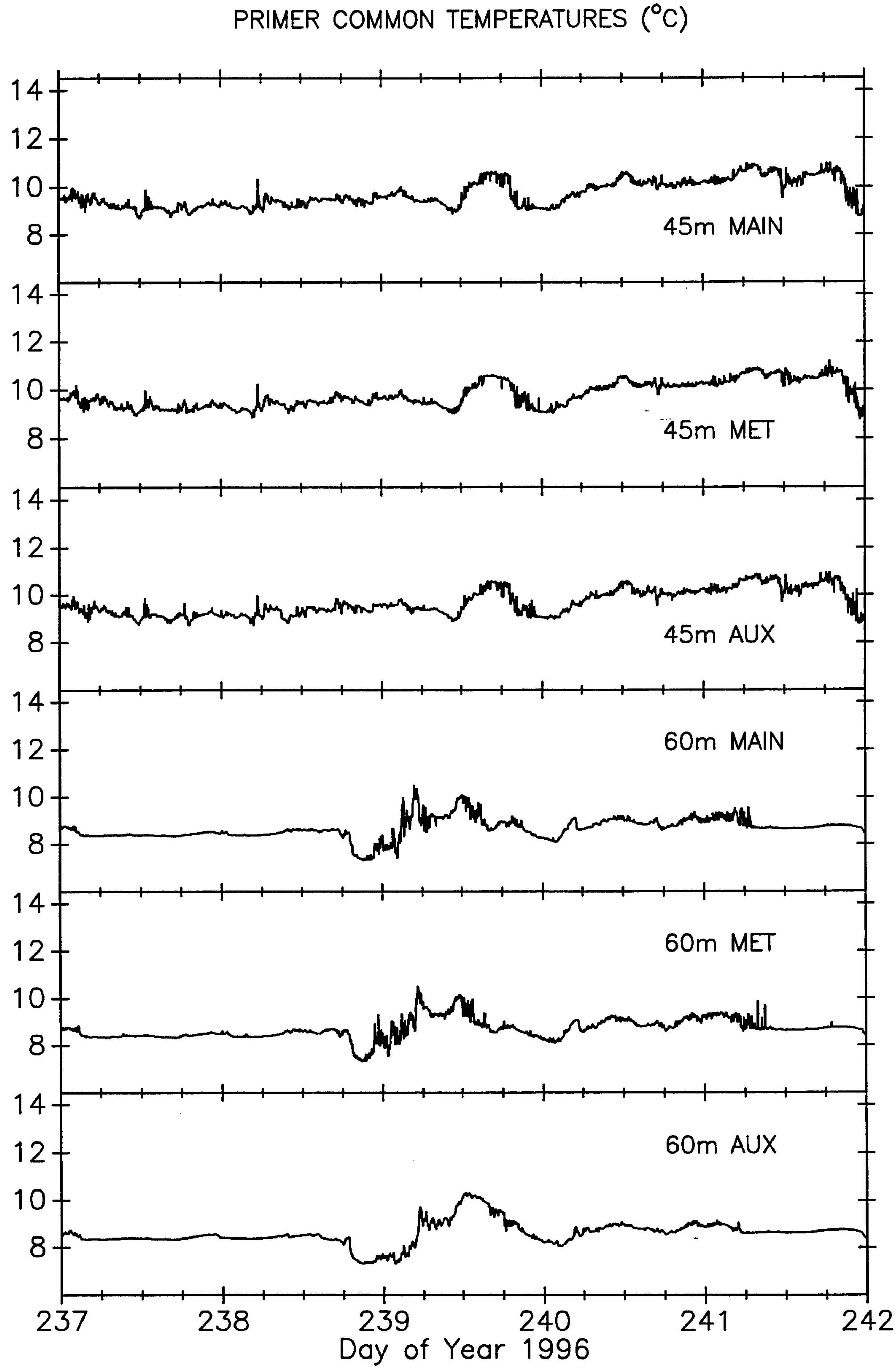
PRIMER COMMON TEMPERATURES (°C)



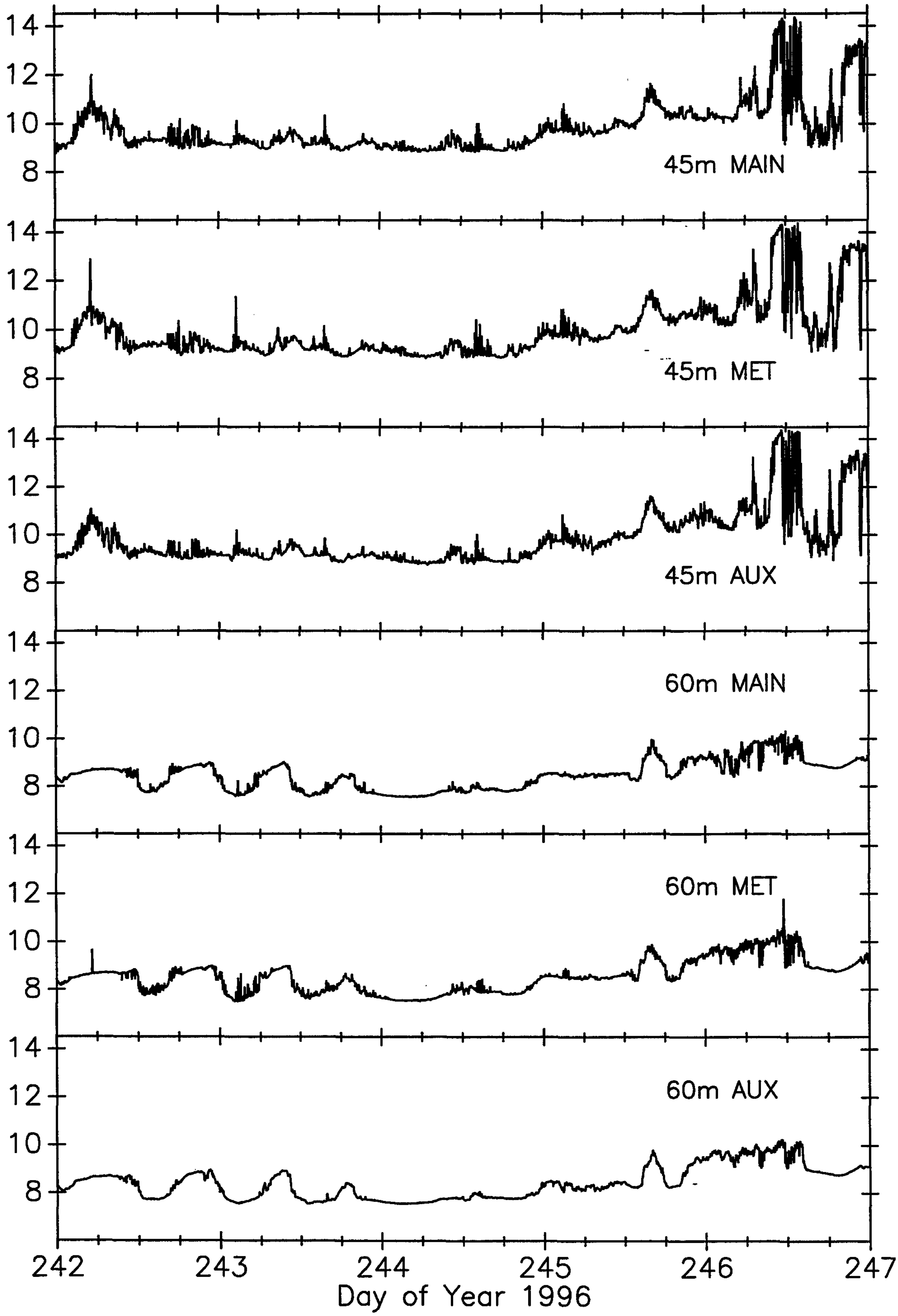
PRIMER COMMON TEMPERATURES (°C)



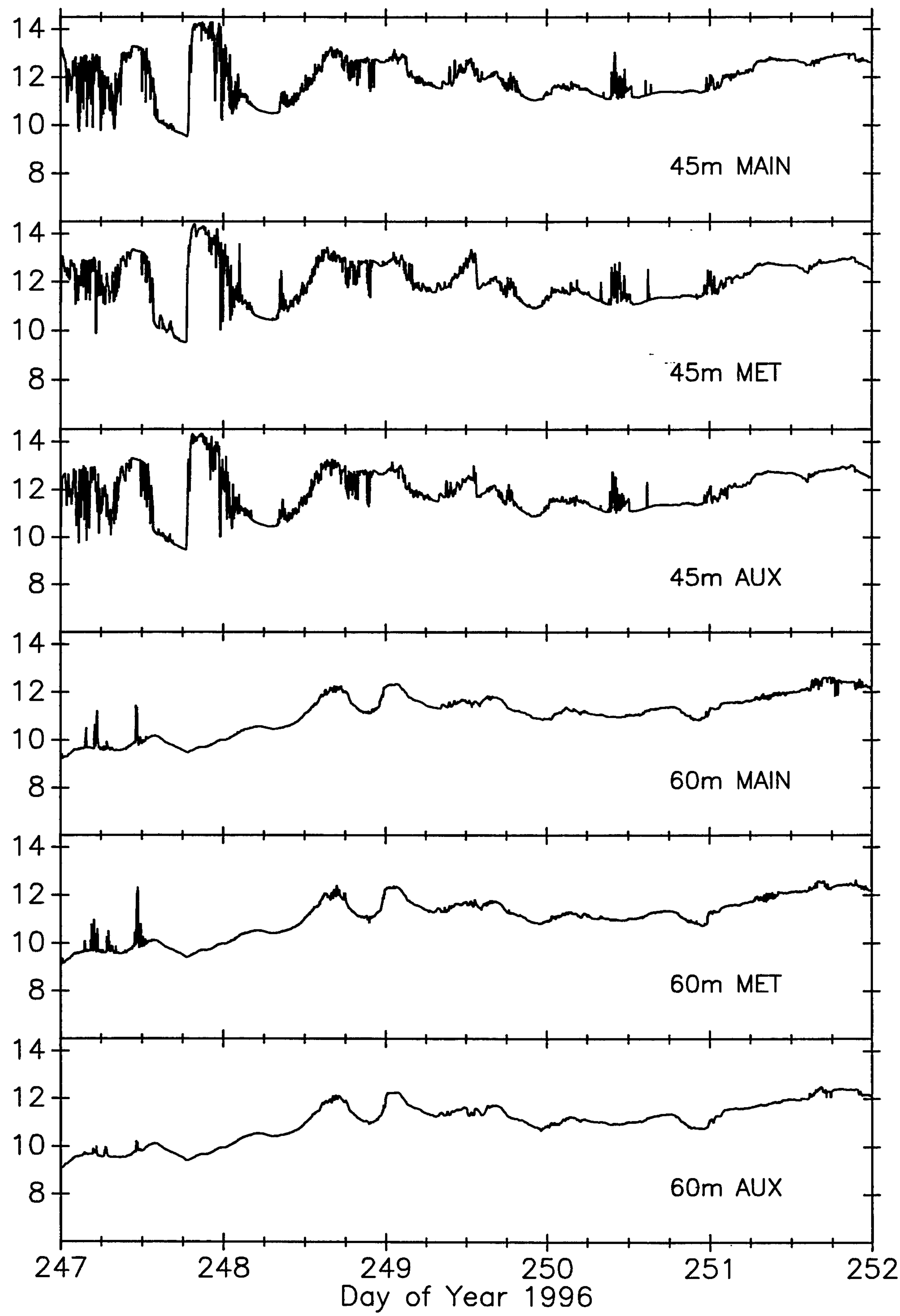

PRIMER COMMON TEMPERATURES (°C)
45m MAIN
45m MET
45m AUX
60m MAIN
60m MET
60m AUX
14
12
10
8
232
233
234
235
236
237
Day of Year 1996


PRIMER COMMON TEMPERATURES (°C)
45m MAIN
45m MET
45m AUX
60m MAIN
60m MET
60m AUX
14
12
10
8
237
238
239
240
241
242
Day of Year 1996

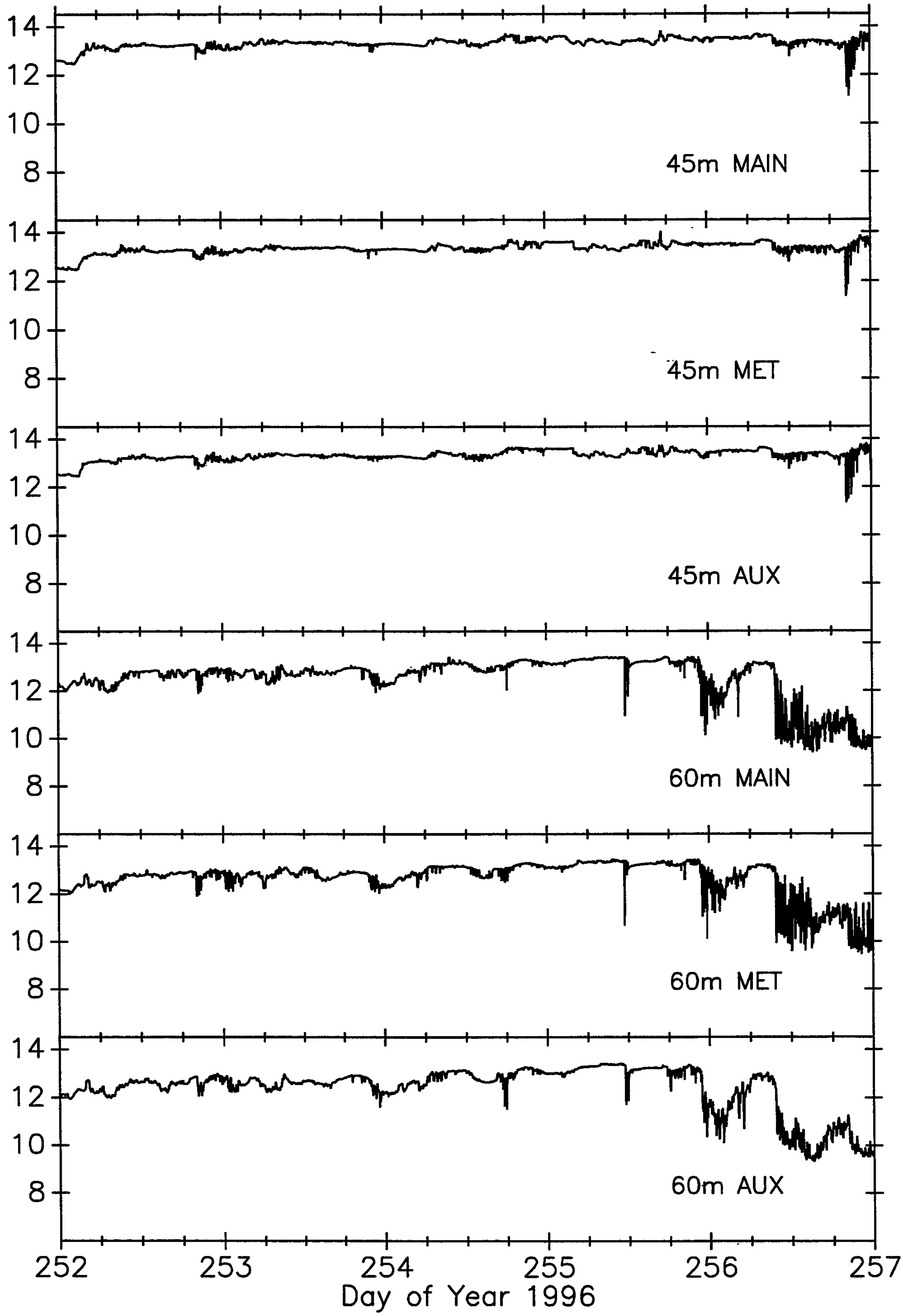
PRIMER COMMON TEMPERATURES (°C)



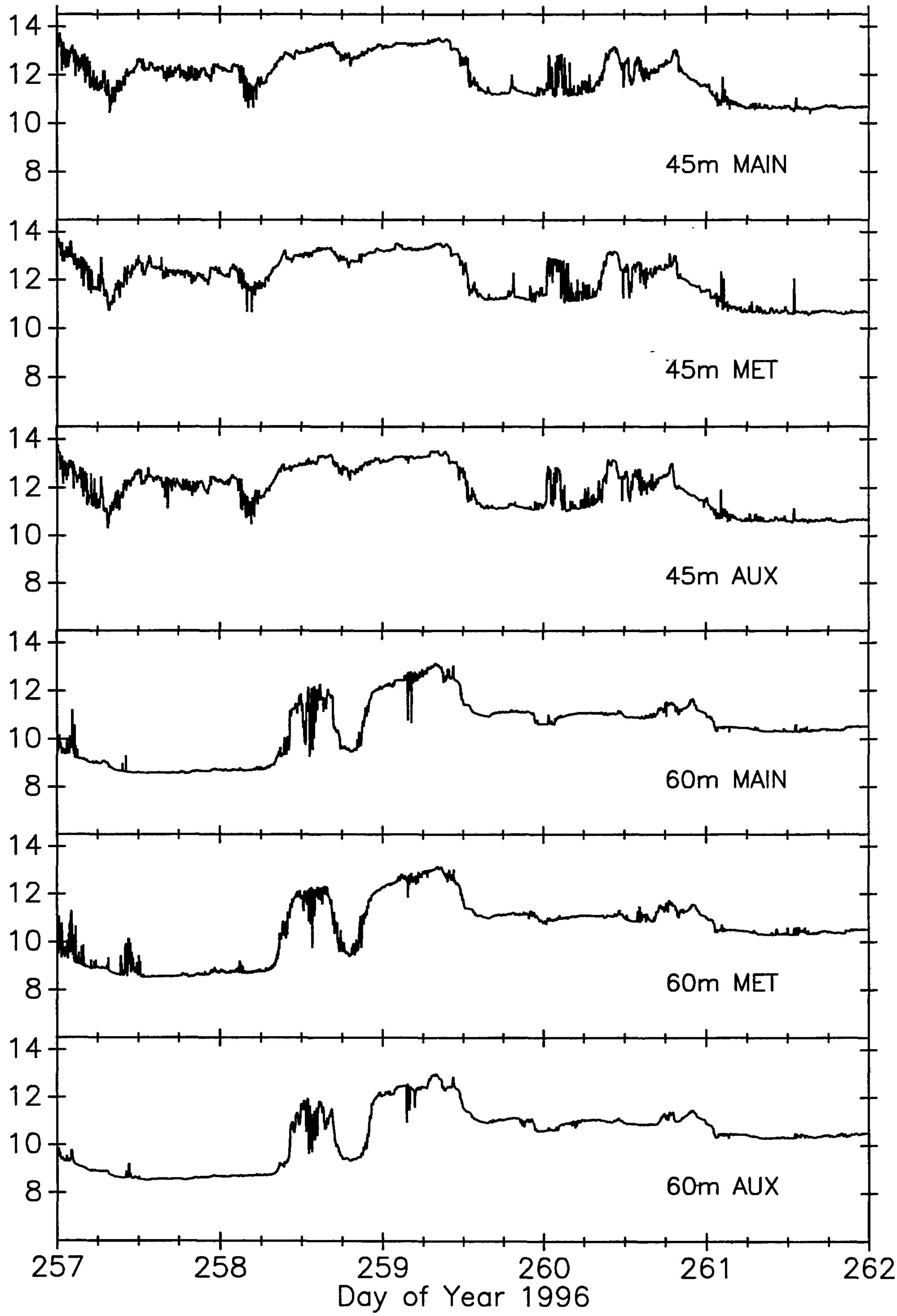
PRIMER COMMON TEMPERATURES (°C)



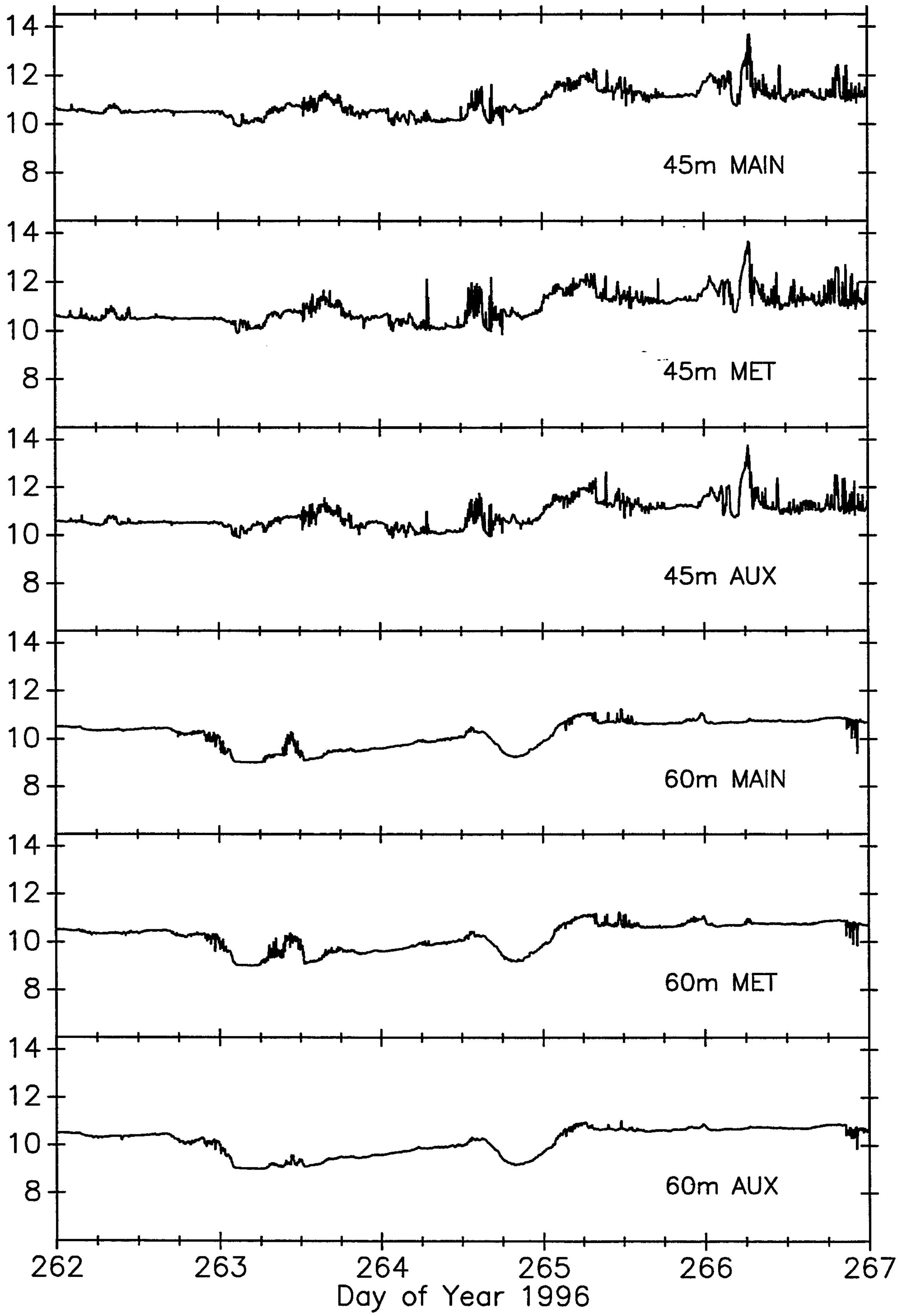
PRIMER COMMON TEMPERATURES (°C)



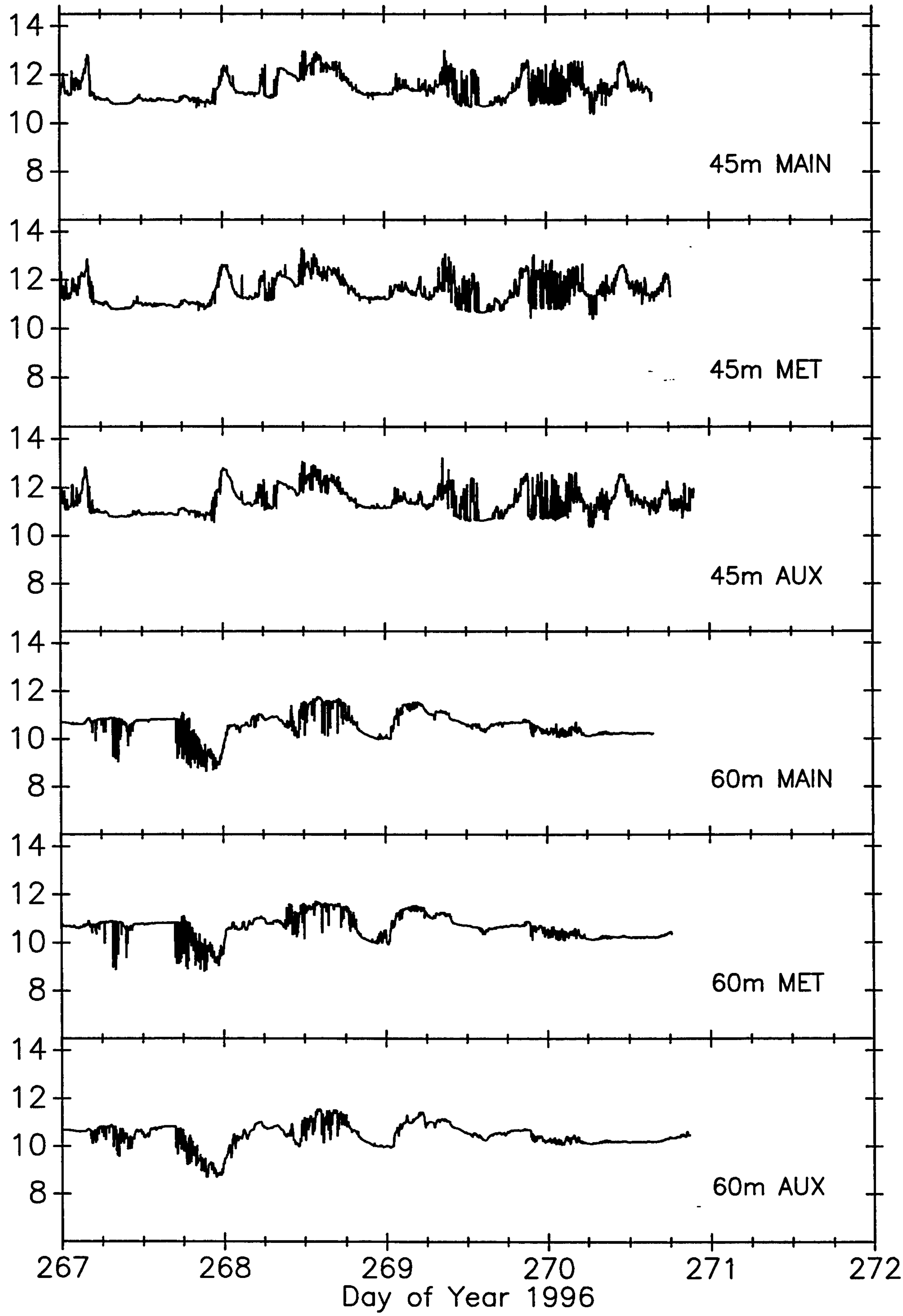
PRIMER COMMON TEMPERATURES (°C)



PRIMER COMMON TEMPERATURES (°C)



PRIMER COMMON TEMPERATURES (°C)



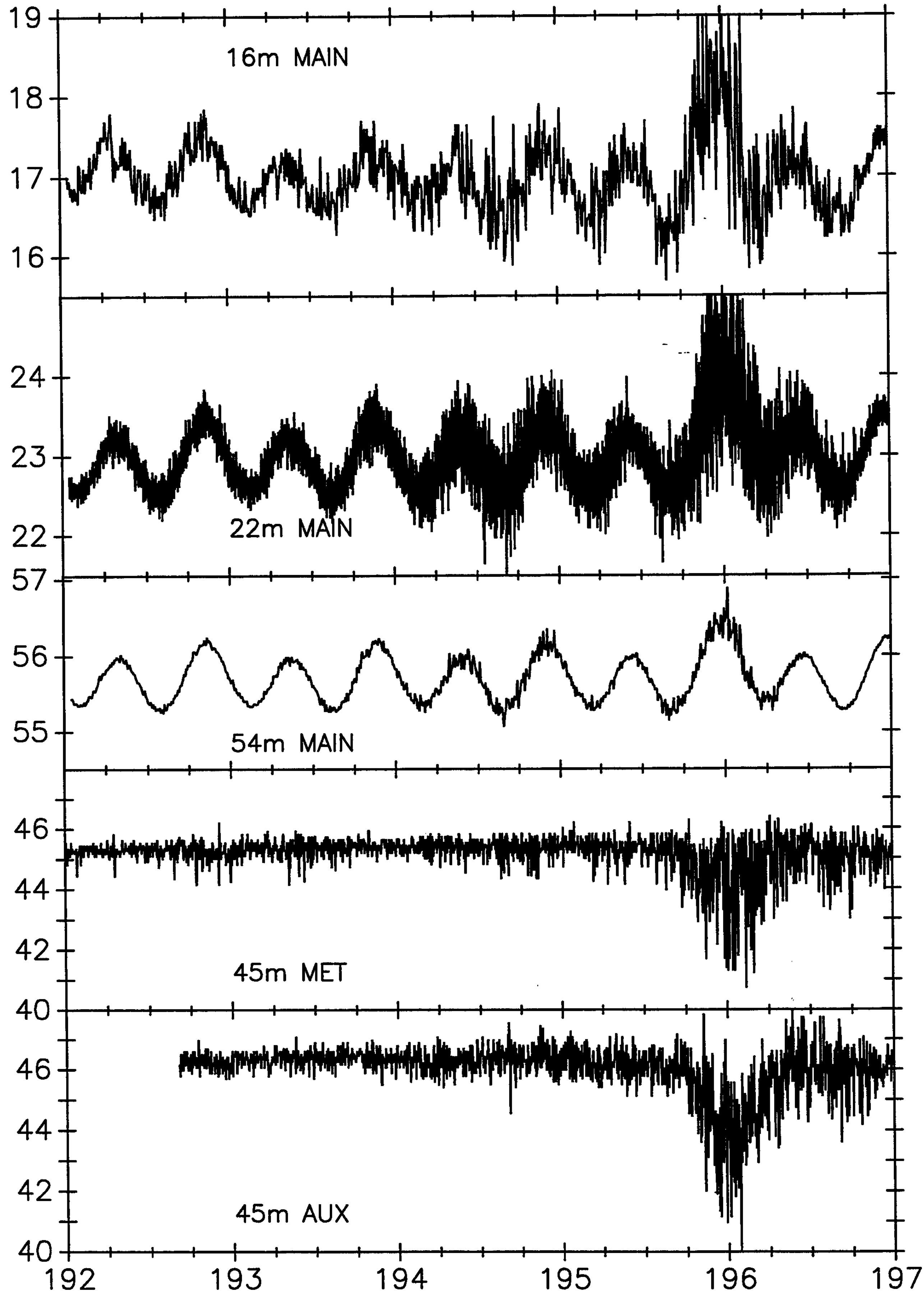
PRESSURE Time Series

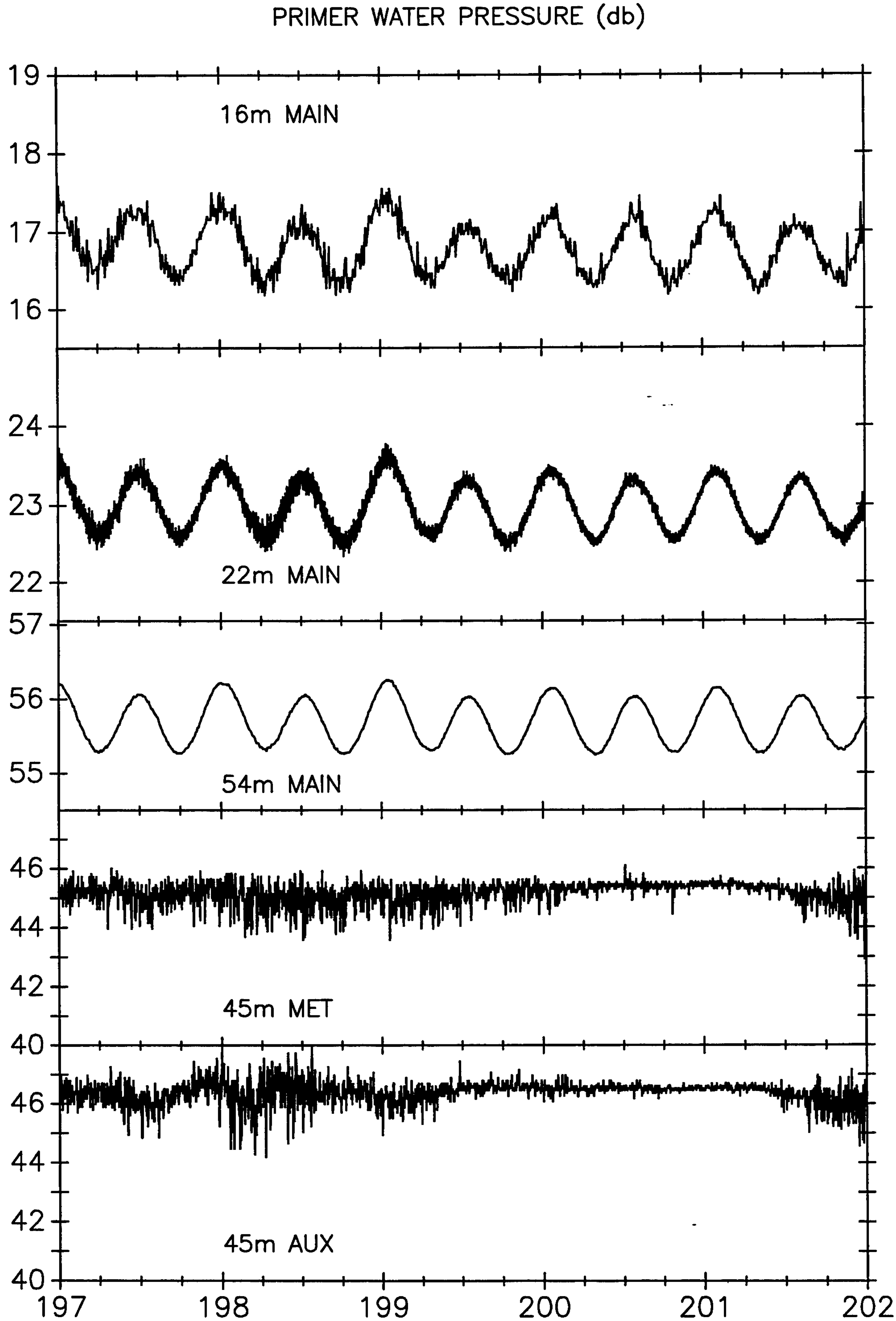
Main, Met, and Aux Moorings

Unfiltered

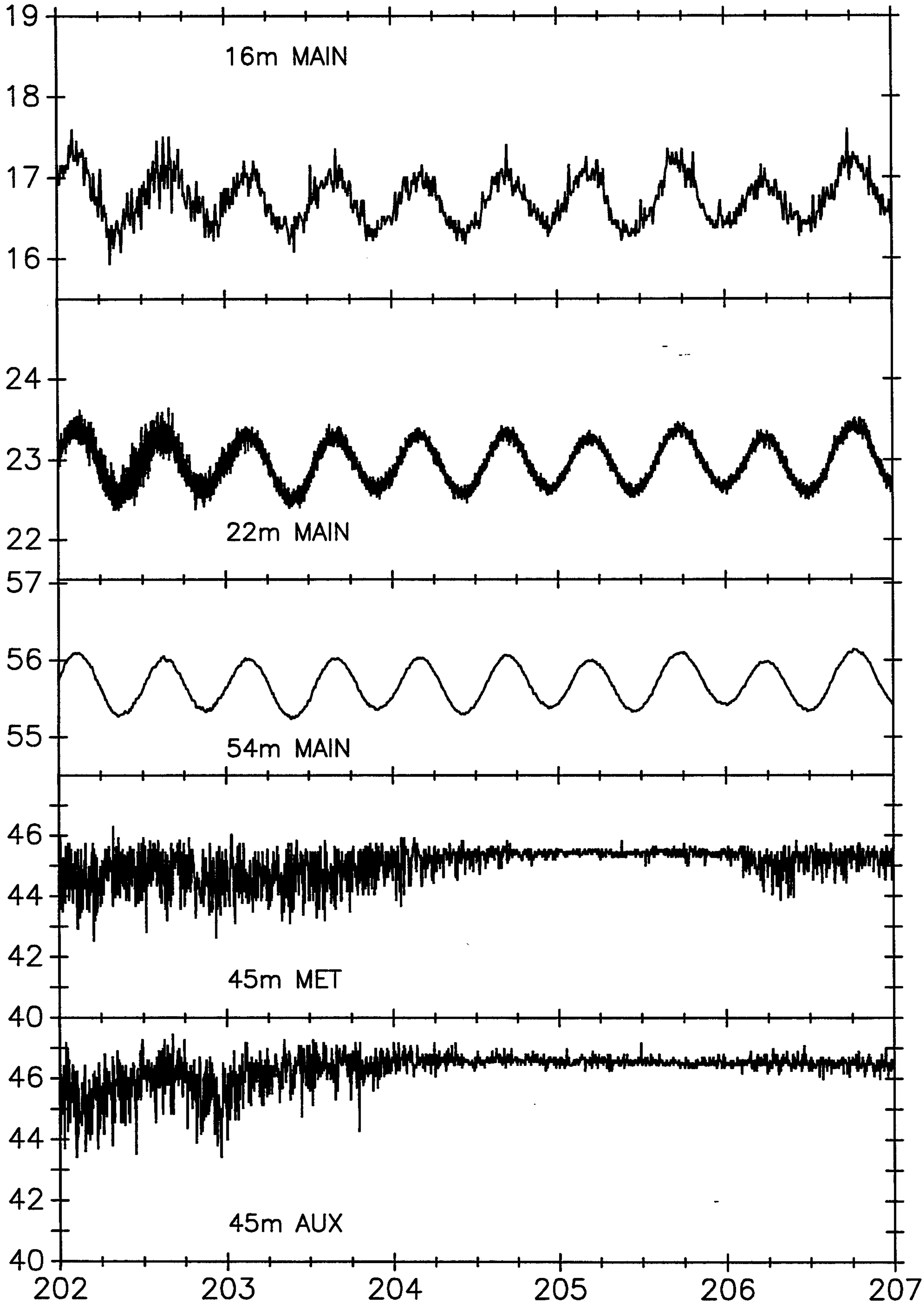
Pressure from instruments deployed on the Main, Met, and Aux moorings: 16 m, 22 m, and 54 m on the Main mooring, and 45 m on the Met and Aux moorings. Consult Tables 1-3 for the instrument types and serial numbers. Pressures are not filtered. Sampling rates are shown in Tables 1-3.

PRIMER WATER PRESSURE (db)

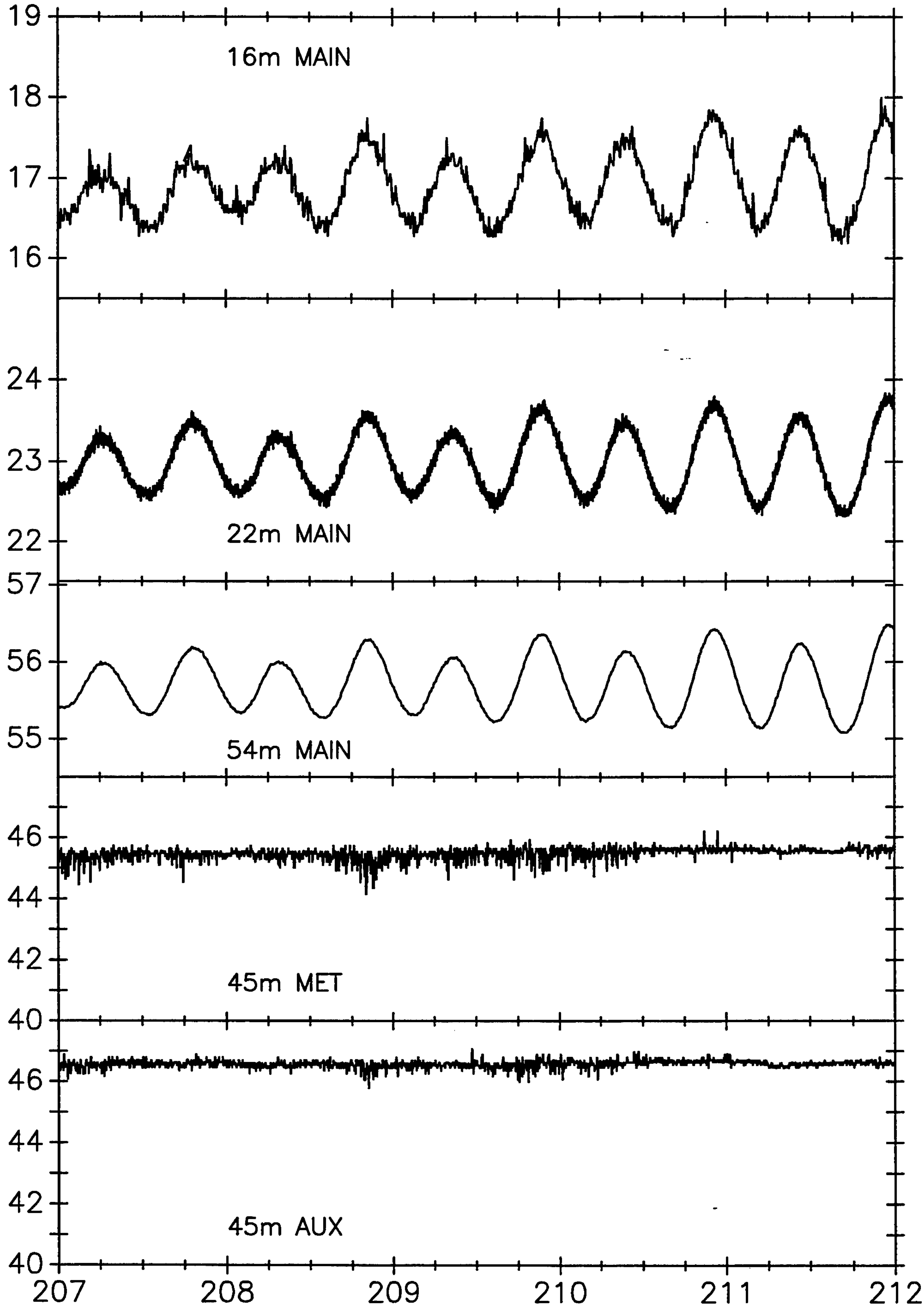



PRIMER WATER PRESSURE (db)
16m MAIN
22m MAIN
54m MAIN
45m MET
45m AUX
19
18
17
16
24
23
22
57
56
55
46
44
42
40
46
44
42
40
197
198
199
200
201
202

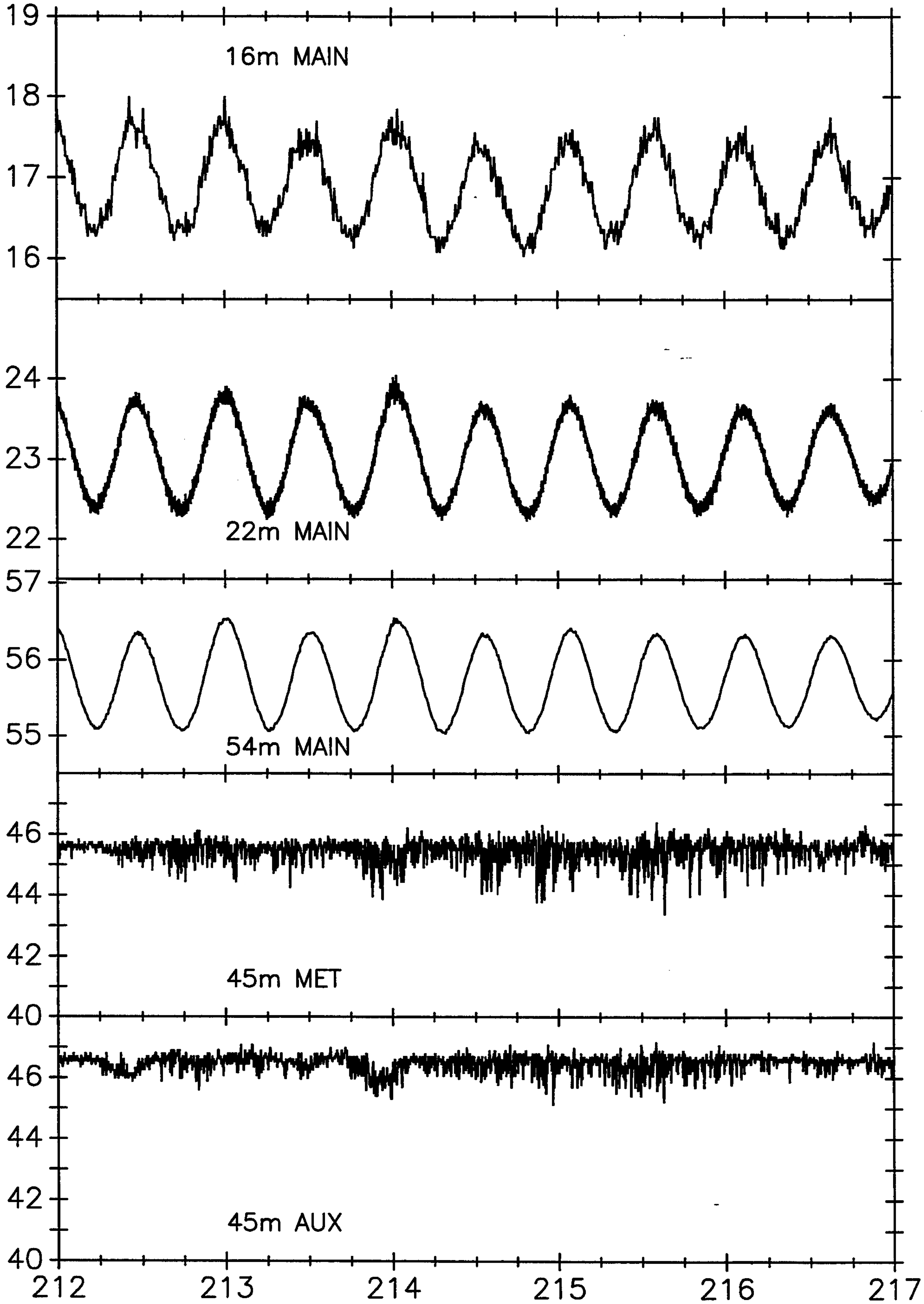
PRIMER WATER PRESSURE (db)



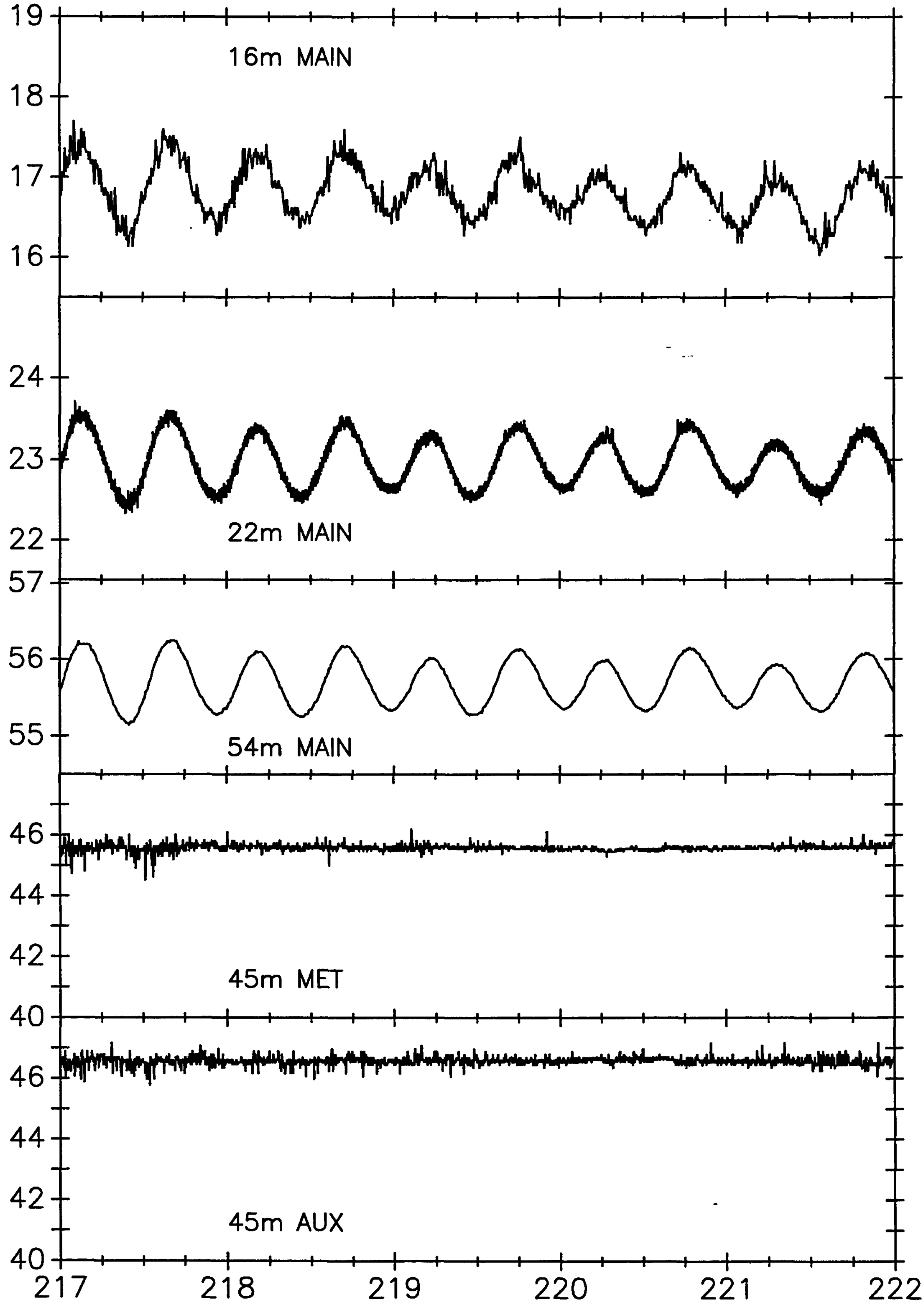
PRIMER WATER PRESSURE (db)

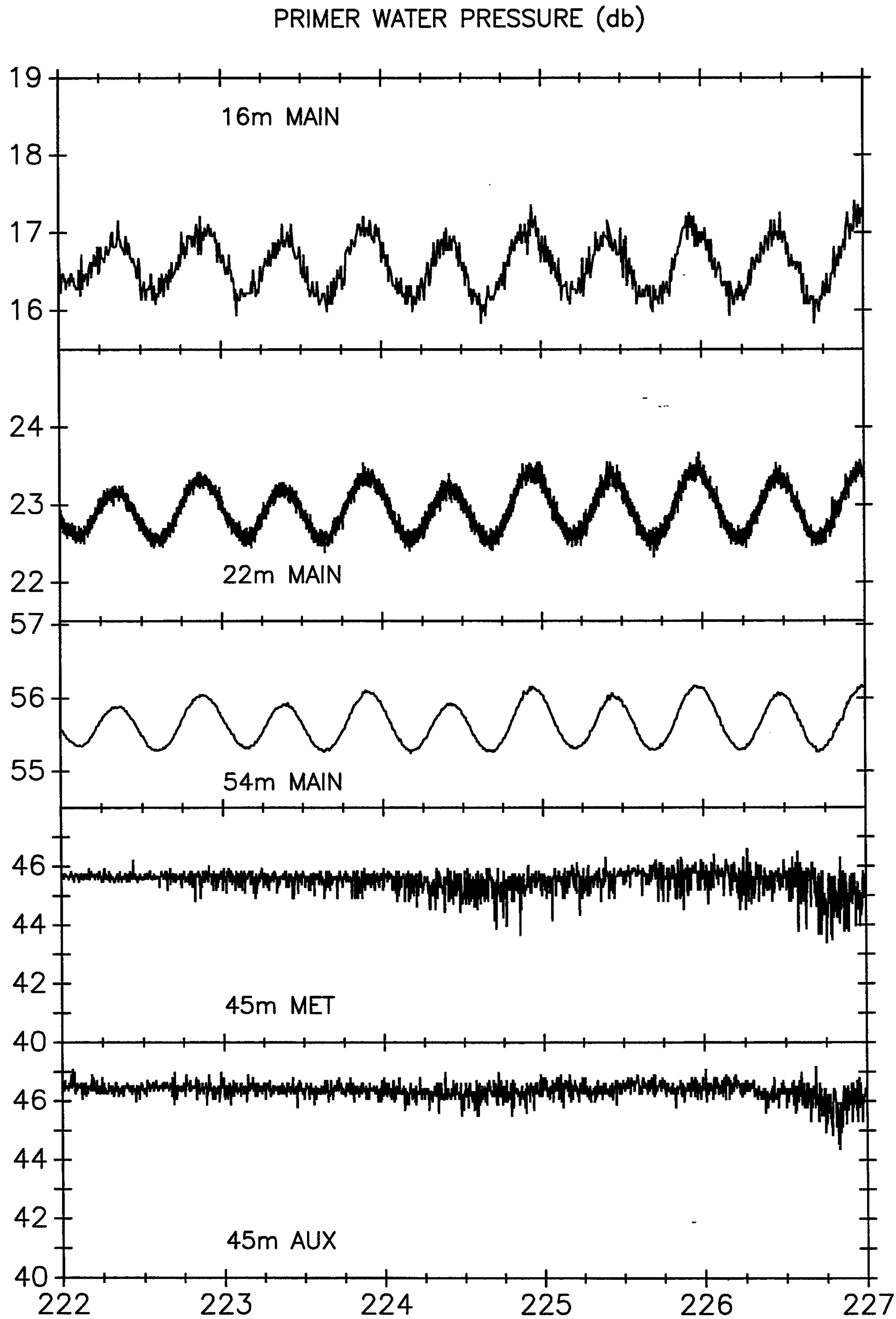


PRIMER WATER PRESSURE (db)



PRIMER WATER PRESSURE (db)

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22m MAIN
54m MAIN
45m MET
45m AUX
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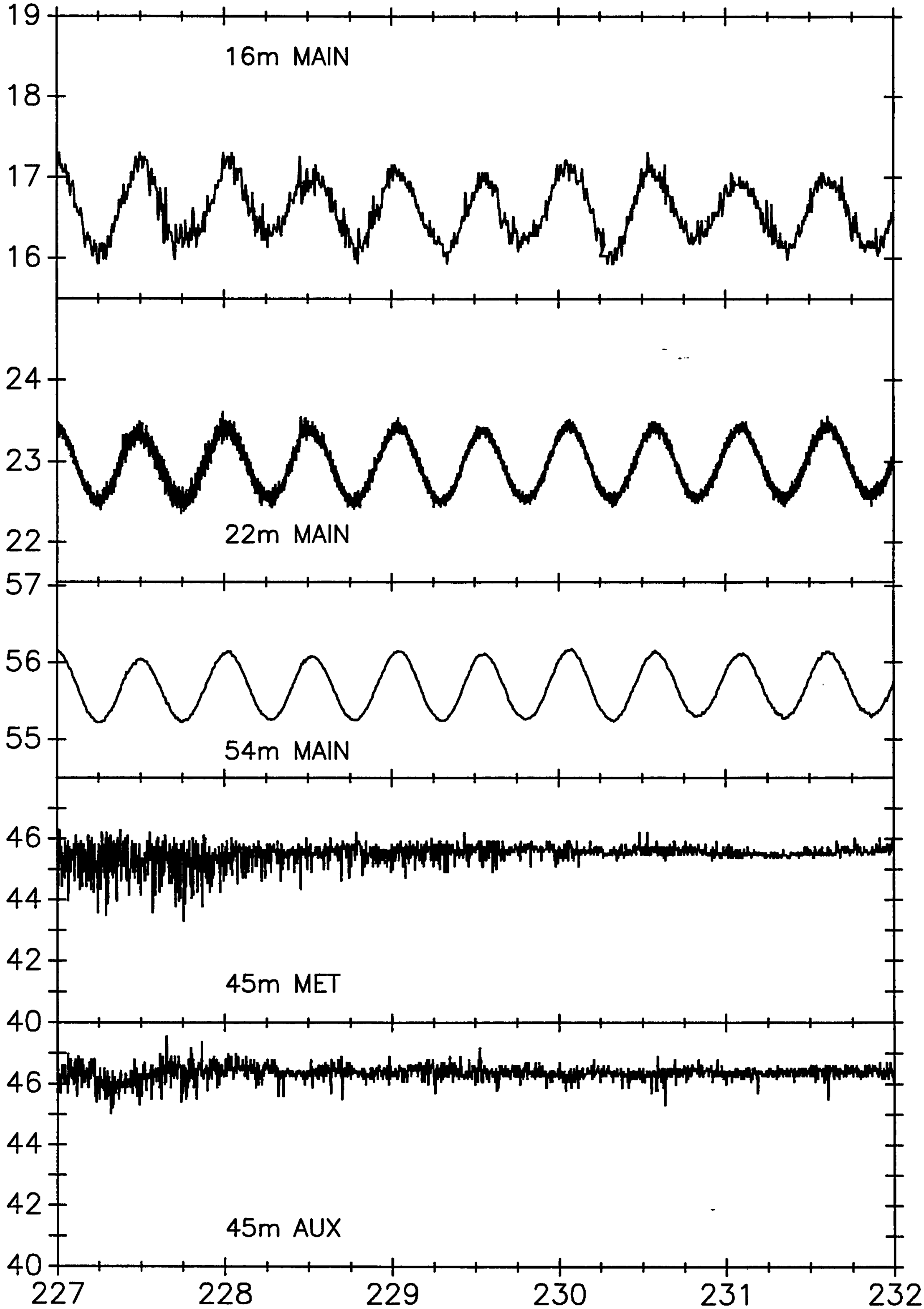
PRIMER WATER PRESSURE (db)



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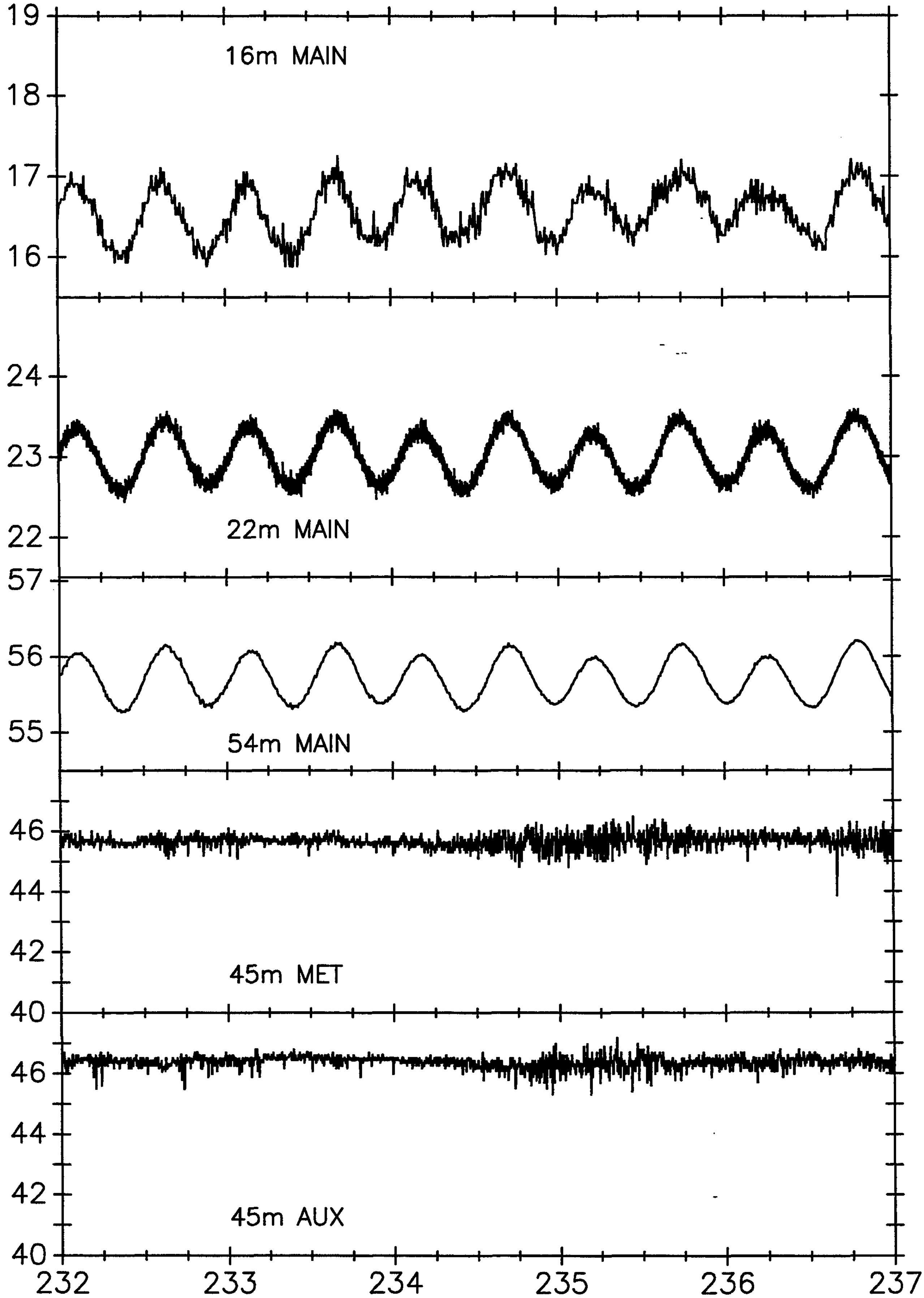

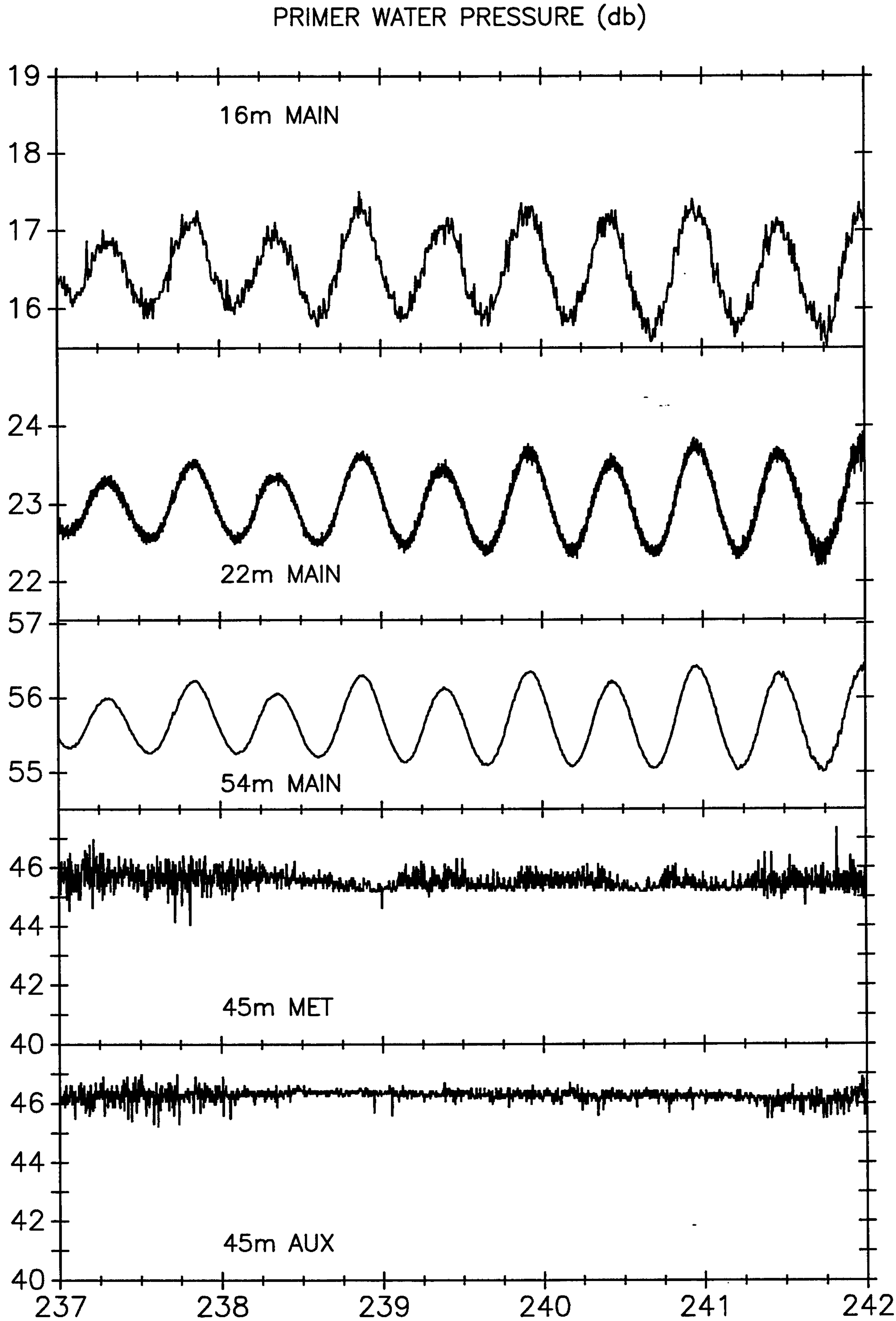
PRIMER WATER PRESSURE (db)
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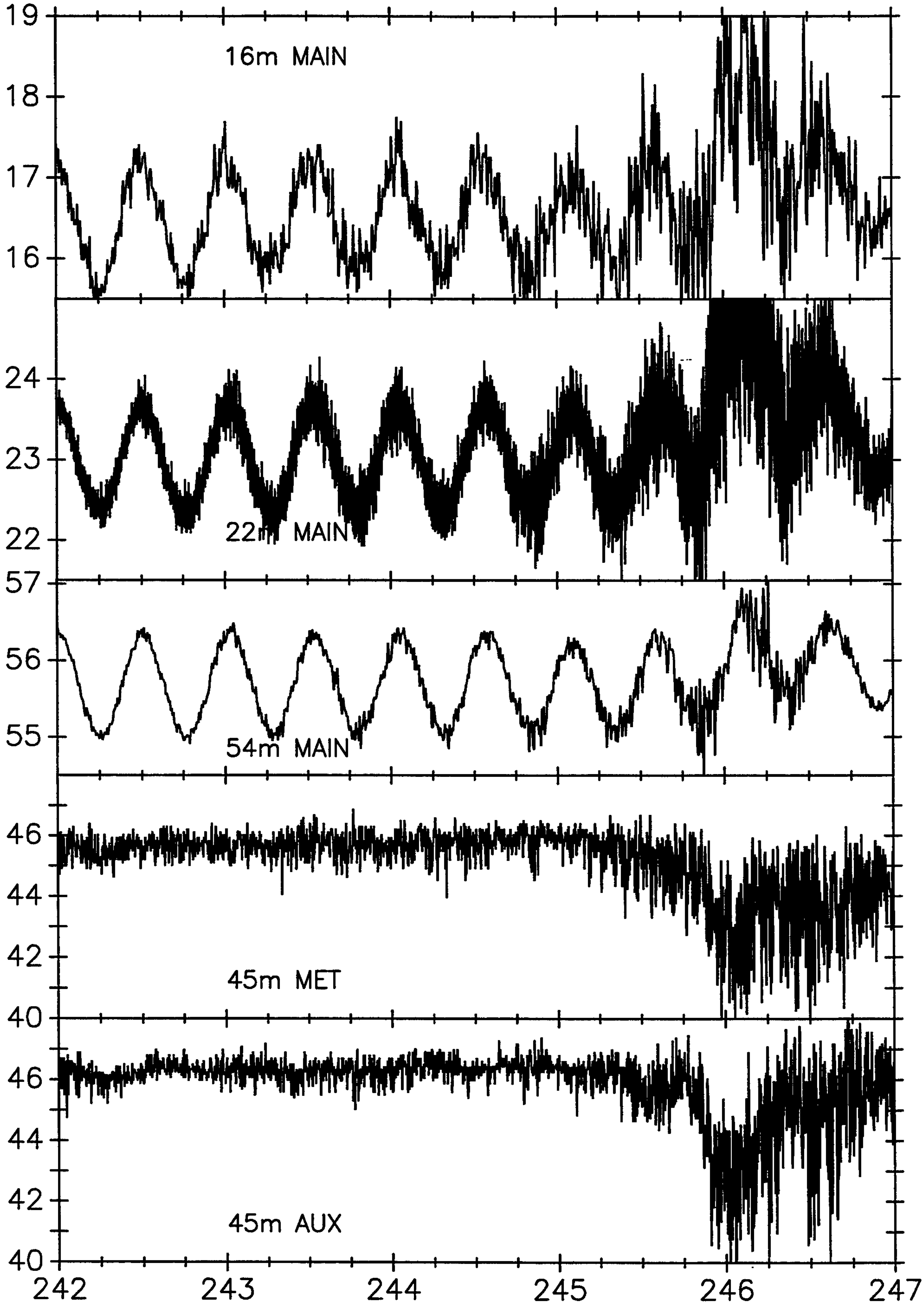
PRIMER WATER PRESSURE (db)



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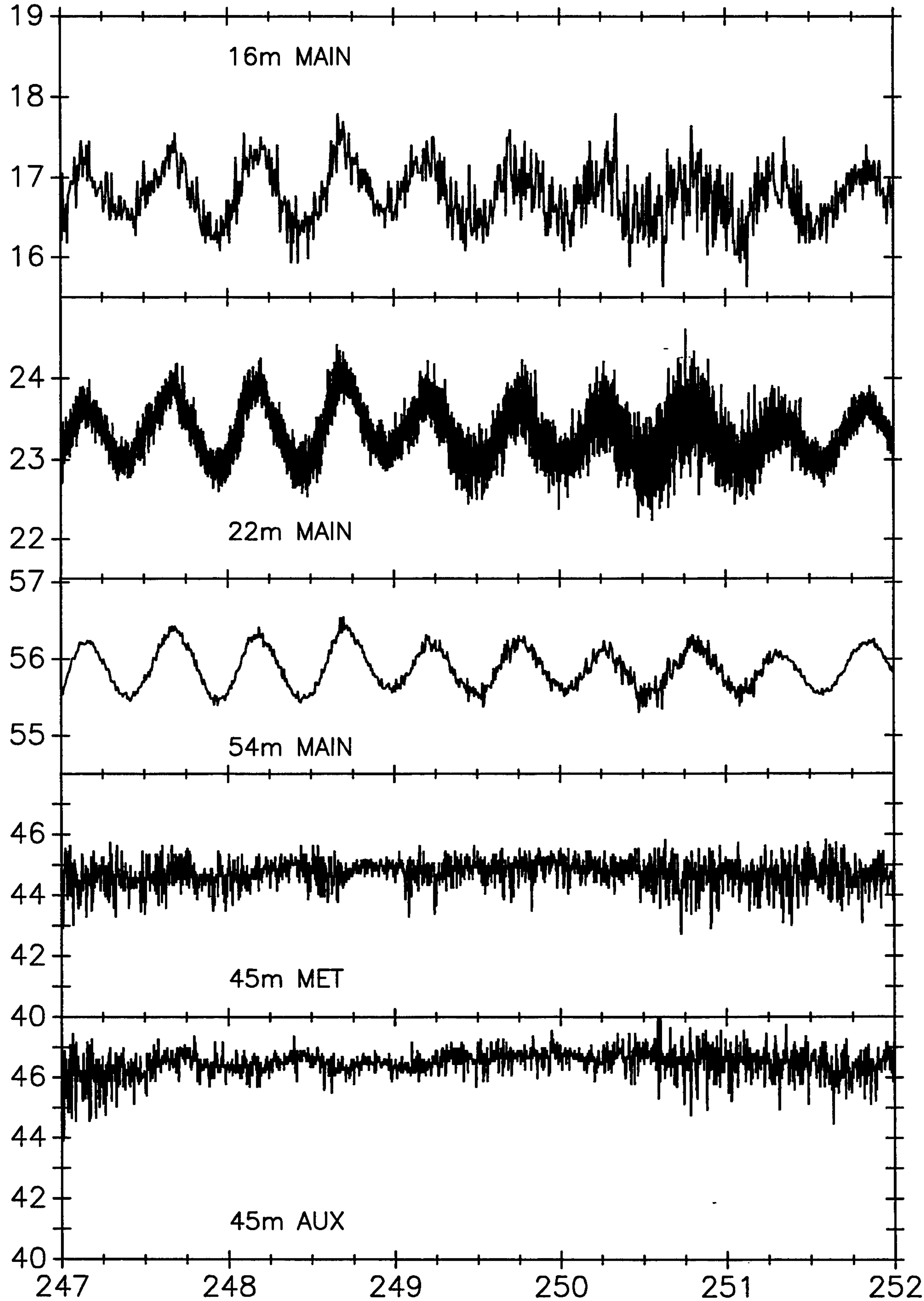

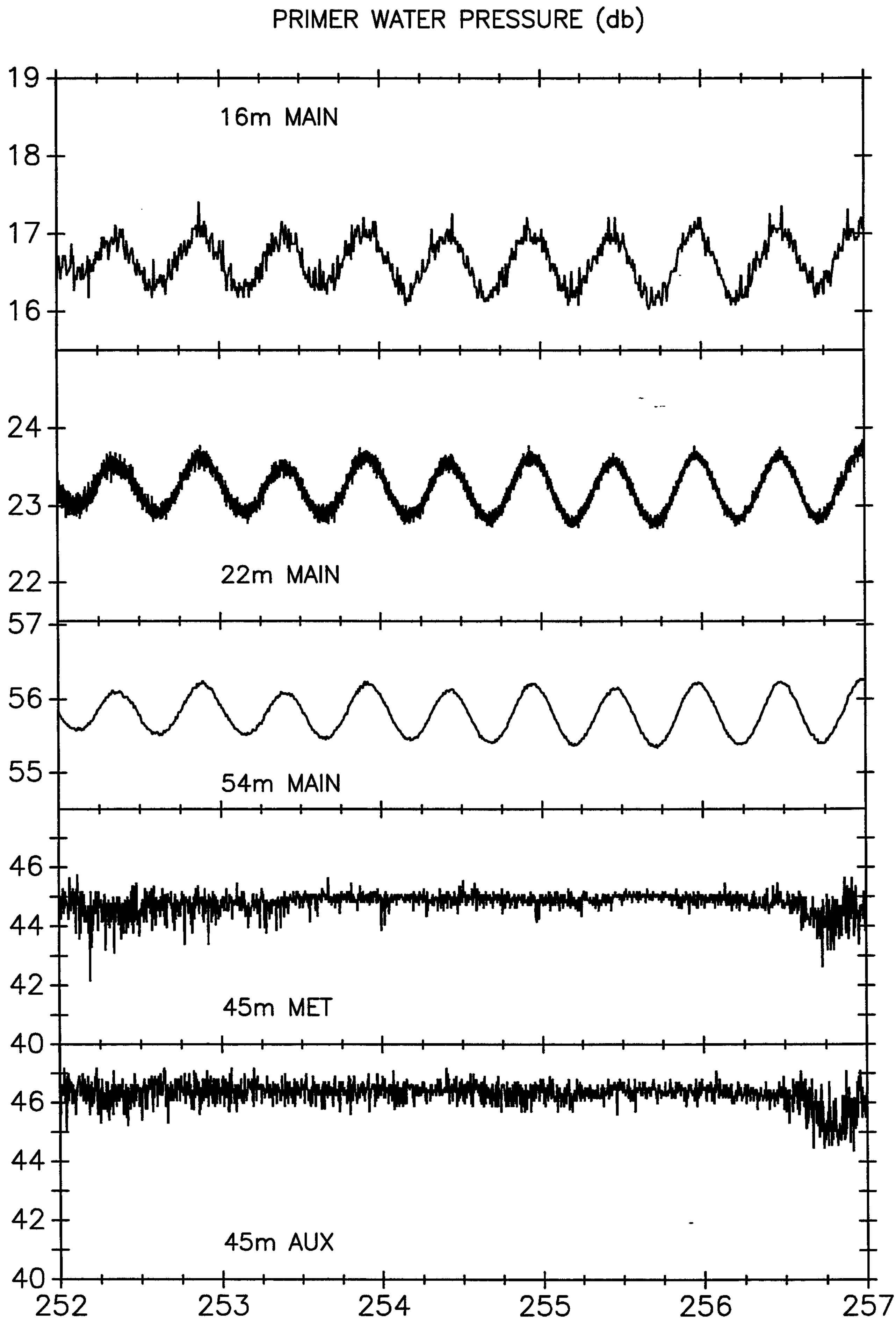
PRIMER WATER PRESSURE (db)
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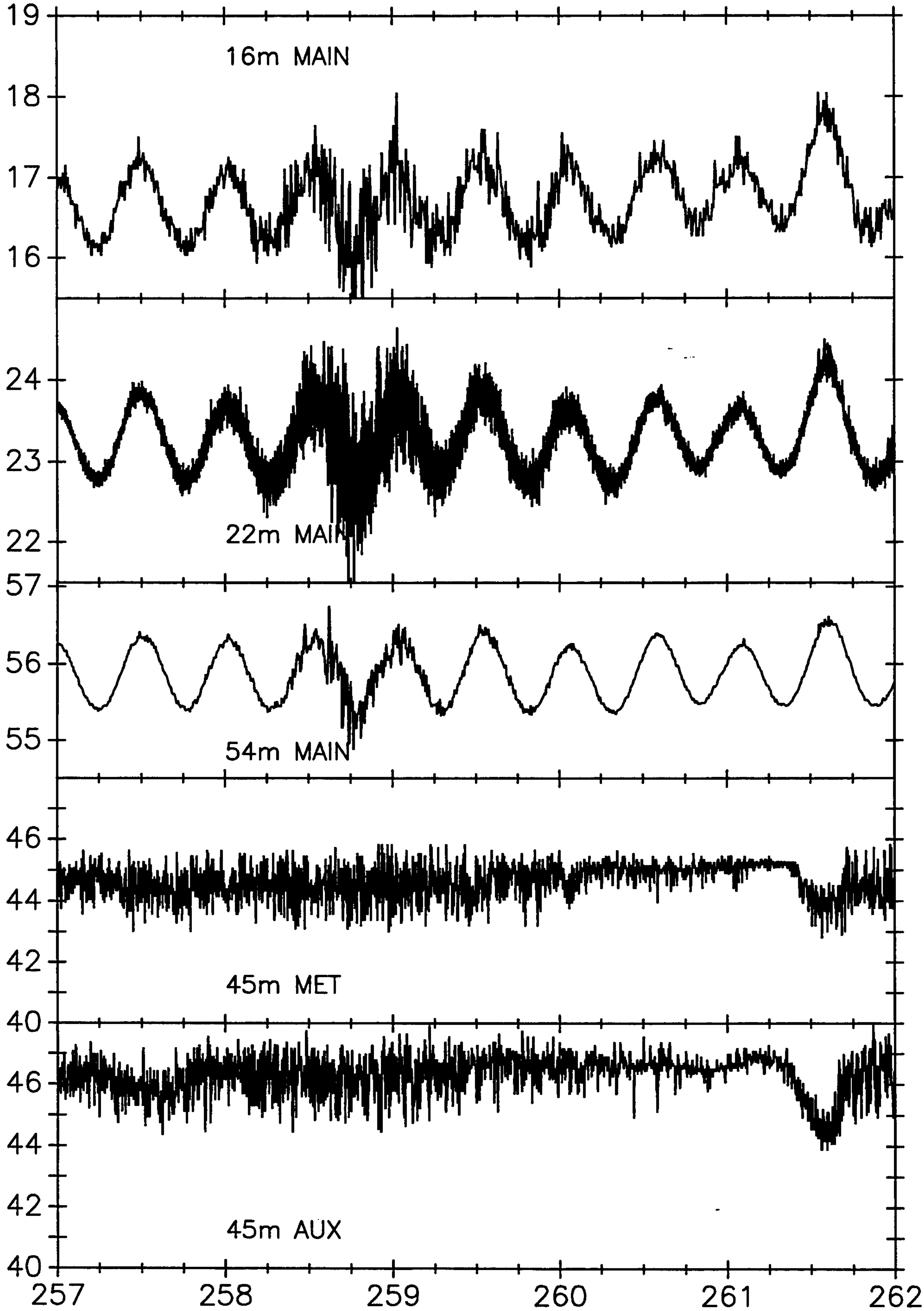

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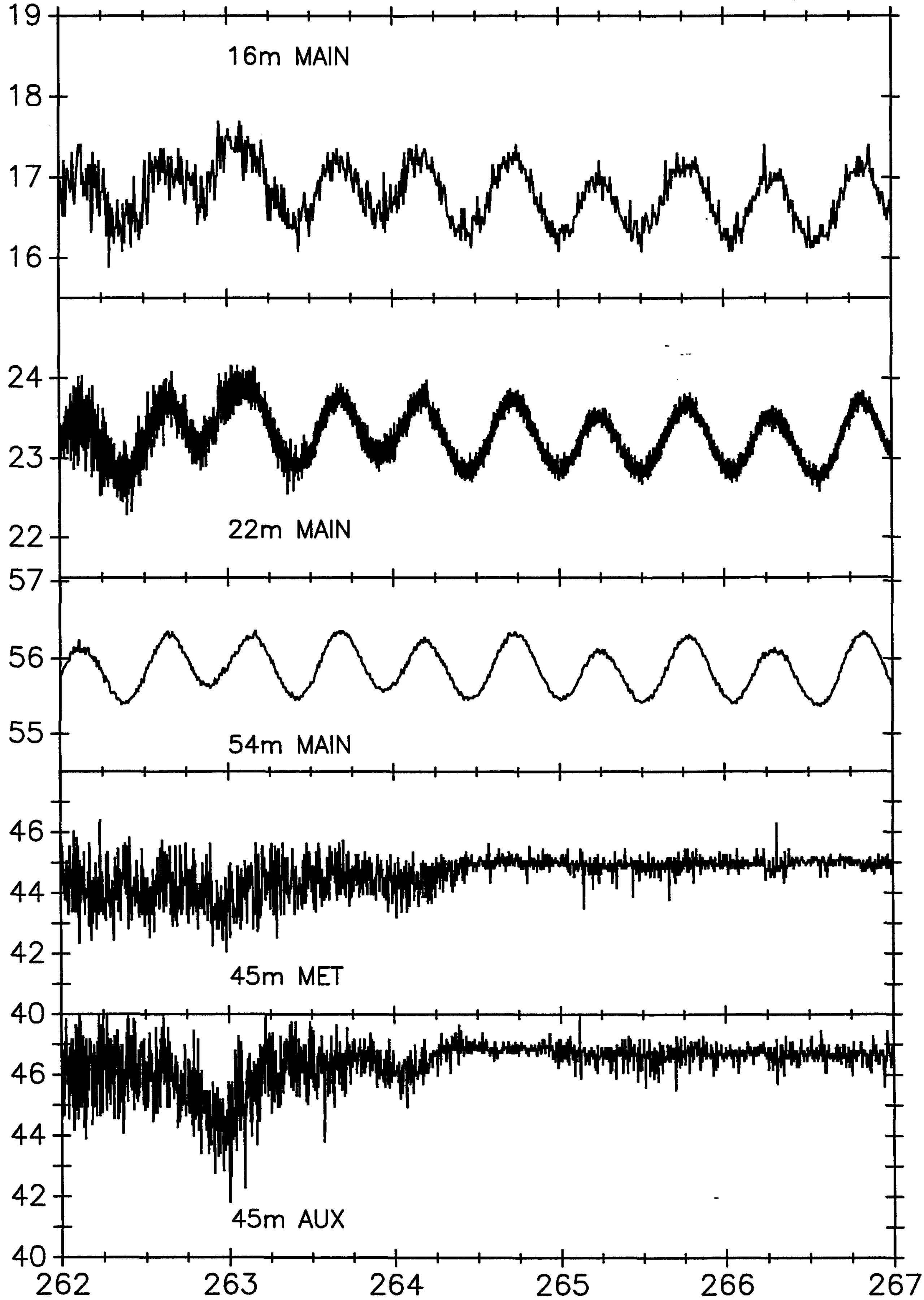

PRIMER WATER PRESSURE (db)